Volume 24, Number 4, February 28, 1970

NUCLEAR SCIENCE ABSTRACTS

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

ISHIHARA, T.
Accumulation of fallout ^{137}Cs in newborn infants, 23:50538
ISHIHARA, Toyokuki
Shielding effect of paraffin, water, soil, concrete, Fe, and Pb for high-energy neutrons, 23:51748

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

MELPHALAN
effects on proliferation of cultured antigen-stimulated spleen cells from mice, dose-response curve for, 23:50820
MEMBRANE FILTERS
design for removal of cell-free Streptococcus faecalus from bacteria cultures in fermentation tank, 23:49996 (UCRL-18667, pp 322-9)
MEMBRANES
radiation effects on nuclear, in salivary gland cells of butterfly larvae, 23:50355
radiation effects on permeability of potassium ions through, of mouse ascites carcinoma cells, electron and x, 23:50817
radiation effects on, in mitochondria of intestinal epithelial cells in mice, cobalt-60 γ, 23:50816
MENDELEVIUM
separation from einsteinium and fermium by electrolysis, 23:49772 (UCRL-18667, pp 277-312)
separation from sodium acetate solutions by solvent extraction using sodium amalgam, 23:49772 (UCRL-18667, pp 277-312)
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51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. (Los Alamos Scientific Lab., N. Mex.). Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

is indexed as:

LOS ALAMOS SCIENTIFIC LAB., N. MEX.
Fabrication of boron carbide rings and disks, 23:51093 (LA-4164)

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstract 5822.

5582 (BNWL–1216) JUSTIFICATION FOR INERT-ATMOSPHERE SHIELDED SAMPLING AND ANALYTICAL FACILITIES FOR THE FFTF. Lust, L. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

Extensive sodium sampling and analysis facilities are necessary to meet the FFTF goals of safe sustained operation, high use factor, and controlled test conditions. Shielded sampling facilities must include remotely operated equipment for obtaining sodium metal samples and distillation residues. The analytical facility must be capable of determining a wide variety of trace-level impurities in radioactive and nonradioactive sodium. The cost of remote, shielded sampling and analytical facilities is amply justified by the ultimate capability, flexibility, and safety they provide. (auth)

5583 (EUR–4388) SOME CHEMICAL PROCEDURES FOR THE RADIOLOGICAL MONITORING OF THE ENVIRONMENT. de Bortoli, M. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center); van der Stricht, E. (European Communities, Luxembourg. [Commission]). 1969. 58p. Dep. CFSTI (U. S. Sales Only).

Some chemical methods used at the Protection Service by the group charged with the survey of environmental radioactivity on the site of the Euratom Ispra Establishment are described. Particularly, procedures are given for the separation of strontium, cesium, and plutonium and for the determination of uranium in some materials like water, atmospheric dust, and soil, and determination of other materials in the food chains. (auth)

Chemical and Spectral Procedures

Refer also to abstract 5655.

5584 EMISSION FLAME PHOTOMETRY: A NEW LOOK AT AN OLD METHOD. Pickett, E. E.; Koirtyohann, S. R. (Univ. of Missouri, Columbia). Anal. Chem.; 41: 28A-32A; 34A; 36A-38A; 40A; 42A(Dec 1969).

A survey is given of some recent developments in flame emission spectroscopy (FE), which suggest that neglect of the method is unwarranted and that the method deserves a roughly equal place beside atomic absorption (AA) in the well-equipped analytical laboratory. A discussion of the two methods is given. The third available mode of operation with flames, atomic fluorescence (AF), is discussed more briefly. Data on detection limits, free atom formation fractions in flames, and spectral interferences in AA are tabulated. 39 references. (P.C.H.)

5585 THE INTERACTION OF THE RARE EARTH ELEMENT IONS WITH 6,7-DIHYDROXY-2,4-DIPHENYLBENZOPYRANOL. Poluektov, N. S.; Sandu, M. A. (Inst. of General and Inorganic Chemistry, Kiev). Zh. Anal. Khim., 24: 1472-6(Oct. 1969). (In Russian).

Ions of the rare earth elements interact with 6,7-dihydroxy-2,4-diphenylbenzopyranol 6-hydroxy-2,4-diphenyl-7H-benzopyran-7-one in aqueous solutions at pH 5 to 8 and form colored complex compounds. It was found by a spectrophotometric method that $MeOH^{2+}$ ions participate in the reaction, displace one proton from the ligand molecule and form a $MeOHL^{+}$ complex. The cation nature of the complex particles was confirmed by sorption on the KU-2 cation exchanger in the Na-form. Constants of the complex formation were calculated. A spectrophotometric method is suggested for determining yttrium in the presence of lanthanum which is based on masking lanthanum with sodium sulfate. (auth)

5586 EXTRACTION–PHOTOMETRIC DETERMINATION OF TELLURIUM IN SEMICONDUCTORS WITH BISMUTHIOL DERIVATIVES. Busev, A. I.; Simonova, L. N.; Zayukova, N. D. (Moscow Univ.). Vestn. Mosk. Univ., Ser. II, Khim., No. 1, 119-21 (1968). (In Russian).

5-Mercapto-3-(2-naphthyl)-1,3,4-thiadiazole-2-thione (I) and 3-(2,3-dimethoxyphenyl)-5-mercapto-1,3,4-thiadiazole-2-thione (II) can be used for the determination of Te in semiconductors based on Ga or In without preliminary separation. The yellow complexes formed have molar extinction coeff. of 29,500 for I and 32,450 for II at 330 nm and the extinctions are proportional to the concentration of Te in the range 10 to 100 μg per 25 ml. Finely powdered indium phosphide (0.1 to 0.5 g) is moistened with water and dissolved by heating with 6 ml of HNO_3–HCl (1:1); 2 ml of H_2SO_4 is added and, after heating to fumes, the solution is cooled and made up to 50 ml with water. Indium or gallium arsenide is dissolved in an arsenic distillation apparatus by heating with 5 ml of H_2SO_4 (1:1), 3 ml of Br and 3 ml of aqua regia are added and then heated to fumes of SO_3. To an aliquot of either sample solution at pH 1 to 2 is added 5 ml of freshly prepared 0.1% I solution, the solution is extracted with $CHCl_3$ (10, 10 and 5 ml) for 3 to 5 min, and the extinction of the $CHCl_3$ extract is measured at 330 nm against I solution. With II, the procedure is similar, but the solution is extracted for 5 to 10 min and after separation of the phases, the $CHCl_3$ solution is extracted with 15 ml of buffer solution of pH 4.7 to 5.0. The results agree well with those obtained by a polarographic method. (Referativnyi Zh.)

5587 EXTRACTIVE-PHOTOMETRIC DETERMINATION OF ZIRCONIUM. Dzhiyanbaeva, R. Kh.; Abdurakhmanov, M.; Talipov, Sh. T. Nauch. Tr., Tashkent Gos. Univ., No. 284, 70-5 (1967). (In Russian).

The photometric determination of zirconium in model mixtures, silicate minerals, zirconium ores, and in ores containing both zirconium and hafnium was based on extraction of Zr in the presence of sodium salicylate (SS) with chloroform and determination of Zr as a complex with 4(-2-N-methylanabasine-alpha'-azo-) resorcinol (MAAR). The absorption maximum of the 1:4 Zr-MAAR complex is located at 530 mmicron. Minerals and ores containing Fe, Ni, Ti, V, Cr, Mo, Cu, Cd, Be, Sn, P, Mn, Si, and alkali and alkaline earth elements were analyzed by melting with borax and sodium carbonate, oxidation in aqueous HCl solution with H_2O_2, precipitation with phenylarsonic acid, reprecipitation from aqueous NH_4OH solution with $AlCl_3$, and extraction from the KCl buffered aqueous HCl solution in presence of SS with chloroform and MAAR; photometric determination was carried out with MAAR and in parallel tests with alizarin red S. The relative error was 0.4 to 2.2% and went to 3.8% in the presence of Hf. If Hf is present, Zr is determined after addition of citrate ion as masking agent; citrate prevents the formation of the Hf complex with MAAR, but does not interfere with the complexing of Zr. (JPRS)

5588 URANIUM ANALYSIS BY ISOTOPE-EXCITED X-RAY FLUORESCENCE. Gant, Preston L.; Motes, Bill G. (Con-

tinental Oil Co., Ponca City, Okla.). Trans. Amer. Nucl. Soc., 12: 518-19(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5589 ANALYTICAL CHEMISTRY PROGRAM FOR LMFBR/FFTF FUELS. Smith, F. M. (Battelle-Northwest, Richland, Wash.); Hayward, B. R.; Williams, J. F.; Metz, C. F. Trans. Amer. Nucl. Soc., 12: 602-3(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5590 DETERMINATION OF SULFUR ISOTOPE RATIOS IN THE ATMOSPHERIC DIAGNOSTICS PROGRAM AT BNL. Manowitz, B.; Tucker, W. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 487-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5591 CAUSES OF ERROR IN SPECTRAL ISOTOPIC ANALYSIS. Zhiglinskii, A. G.; Kund, G. G.; Khlopina, T. N. Zh. Prikl. Spektrosk.; 10: 205-11(Feb 1969). (In Russian).

It was concluded that one of the most essential components of the nonsystematic error in determination of isotopic composition by atomic spectra is insufficiently good reproduction in different experiments of the shape of the line for the isotopes. Determinations of the isotopic composition of strontium and rubidium verified this. A change in thickness of the interferometer is proposed. (M.C.G.)

5592 ANALYSIS OF HYDROCARBON–DEUTERIUM MIXTURES BY MEANS OF A MASS SPECTROMETER EVACUATED BY AN IONIC PUMP. Frennet, A.; Lienard, G. (Univ., Brussels). Vide; No. 142, 239-43(Jul-Aug 1969). (In French).

Important errors in the measurement of isotopic concentrations in CH_4 and D_2 are due to the presence of a sputter ion pump attached to the mass spectrometer. The role played by the gases previously pumped and buried in the pump is established. In this way, different "memory effects" are evidenced. The conductance of the ion pump has to be reduced by a factor as large as 10^4 in order to reduce the backstreaming of H_2 and HD from the pump to the ion source at a normal level, in typical experiments. In this case, the use of a sputter ion pump is no more interesting. (auth)

5593 EXTRACTION CONCENTRATION OF IMPURITIES DURING THE ANALYSIS OF HIGH PURITY MATERIALS. III. DETERMINATION OF IMPURITIES IN ARSENIC(III) CHLORIDE. Kuz'min, N. M.; Popova, G. D.; Kuzovlev, I. A.; Solomatin, V. S. Zh. Anal. Khim., 24: 899-904(1969). (In Russian).

The extraction of impurities from $AsCl_3$ with 8-hydroxyquinoline (I), 1-phenyl-3-methyl-4-benzoyl-5-pyrazolone (II), diethyldithiocarbamic acid, and pyridylazonaphthol was studied. Al, Bi, Ca, Co, Cu, Fe, Ga, Mg, Mn, Ni, Pb, Zn, and Ti were extracted by using a mixture of I and II. The sensitivity of the determination is 10^{-7} to 10^{-5}% for the various elements. A spectrographic method was developed for the determination of Ag, Al, Ba, Bi, Ca, Co, Cr, Cu, Ga, Fe, In, Mg, Mn, Ni, Pb, Sb, Sn, Te, Ti, Tl, and Zn, which was based on the extraction of $AsCl_3$ with C_6H_6. After extraction of the $AsCl_3$, the aqueous phase was evaporated to dryness, the residue taken up in 1 ml HNO_3, and again evaporated to dryness. The dry residue was mixed with 10 mg graphite powder containing 10% NaCl, and the concentrations of the elements were determined spectrographically. (Selenium-Tellurium Abstr.)

5594 MICROCHEMICAL ANALYSIS OF SOME SELENIUM–TELLURIUM MINERALS. Fer'yanchich, F. A. Tr., Tsent. Nauch.-Issled. Gornorazved. Inst., No. 70, 188-203(1967). (In Russian).

A flow sheet and a detailed systematic procedure are given for microchemical analysis of a Se–Te mineral, which does not contain Au, Ag, Sn, and Hg. The flow sheet provides for determination of the primary components of the mineral (Se, Te, Bi, S), the secondary components (Pb, Cu, Fe, Zn, As, Sb), and silicate rock. Analysis is made from 2 weighed portions. In the 1st weighed portion (10 to 40 mg.), Bi, Pb, Cu, Fe, Zn, Se, Te, As, Sb, and silicate rock are determined; S is determined in the 2nd weighed portion (5 to 15 mg.). The following methods are used to determine discrete elements: potentiometric titration (Te), photometry (Fe), electrolytic deposition (Cu), polarography (Sb and Zn), titrimetry (Pb, Se, and As), and gravimetry (Bi and S). (Referativnyi Zh.)

5595 THIN-LAYER CHROMATOGRAPHIC METHOD FOR THE SEPARATION OF TELLURIUM AND SELENIUM. Rai, J.; Kukreja, V. P. (National Physical Lab., New Delhi). Chromatographia, No. 1, 18-19(1969).

Tellurium and Se (as TeO_3^{2-} and SeO_3^{2-}) were separated by thin-layer chromatography on a silica gel plate. The plate was developed 15 to 20 min at 30°C with the upper phase of a 100:40 amyl acetate–HCl mixture and sprayed with $SnCl_2$ solution to give red and black spots for Se and Te, respectively. The mixture can be resolved also on chromatographic paper by developing 30 to 40 min. (Selenium-Tellurium Abstr.)

5596 SEMIQUANTITATIVE STUDY OF TRACE ELEMENTS IN PYRITE BY SPARK SOURCE MASS SPECTROGRAPHY. Mitchell, R. H. (McMaster Univ., Hamilton, Ont.). Norsk Geol. Tidsskr., 48: 65-80(1968).

Crushed pyrite from hydrothermal and magmatic, marine, fresh water, and metamorphic environments was purified by removing magnetite, ferromagnesian silicates, and pyrrhotite with a magnetic separator, and nonmagnetic silicates and carbonates with clerici solution. Elements from Ti to U were determined with a spark mass spectrometer. The detection limit was 1 ppM and precision ±8%. All pyrites contained Ti, V, Cr, Mn, Co, Ni, Cu, Zn, As, and Se. In addition, Ga, Ge, Y, Zr, Nb, Mo, Sn, Te, Sb, Ba, Ce, La, Pb, and Bi were detected depending on the location. Marine pyrites had higher contents of Ti, V, Cr, Co, Ni, Cu, Zn, and Se than fresh H_2O pyrites. Fresh water pyrites lacked Ag, Sn, and Te and were characterized by a sparse assemblage of trace elements. Authigenic and metamorphic pyrites were characterized by the presence of Mo. Authigenic pyrites contained more As than hydrothermal pyrites. Trace element concentrations varied highly depending on the environment as consequence of actual availability of elements at the site of the pyrite formation. (Selenium-Tellurium Abstr.)

5597 ANALYTICAL APPLICATIONS OF X-RAY EXCITED OPTICAL FLUORESCENCE SPECTRA. 1. APPARATUS AND DIRECT DETERMINATION OF RARE EARTHS IN LANTHANUM OXIDE. Nakajima, Tokunosuke; Kawaguchi, Hiroshi (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment, Japan). Bunko Kenkyu, 18: 210-17(Sept. 1969). (In Japanese).

A rapid, quantitative analytical technique for the analysis of rare earth impurities is described. High-energy x rays are used to excite the rare earth impurities in appropriate matrices. The excited rare earth impurities fluorescence with simple line emission spectra, which can be used for quantitative measurements. Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, and Tm were determined by this method with detection limits ranging from 0.2 to 20 ppM in La_2O_3. Appreciable amounts of Pr, exceeding 500 ppM in some cases were found in commercial La_2O_3, which was used as the raw material for optical glass. Spectrum patterns obtained for each rare earth element in La_2O_3 are also presented. The detection limits in other oxide systems are surveyed and discussed. (NSA of Japan)

5598 GAS CHROMATOGRAPHY FOR INORGANIC COMPOUNDS. ATOMIC ABSORPTION METHOD FOR INORGANIC COMPOUNDS DETECTOR. Niki, Eiji (Tokyo Univ.). Asahi Garasu Kogo Gijutsu Shoreikai Kenkyu Hokoku, No. 14, 571-80 (1968). (In Japanese).

An analytical method of atomic absorption of inorganic compounds, which were separated gas chromatographically, was studied. The advantages of using plasma jet flame and factors influencing measurement with a plasma jet flame were investigated for measurement of Mg, Ca, and Al. In the calculations, the ratio of atomic numbers in the excited state compared to that in the ground state is in the range from 10^{-4} to 10^{-2} at 5000 to 7000°K, and the possibility of interference can be neglected. In order to avoid unfavorable ionization, for instance in case of Mg, the studies should be carried out in outer cone of the flame, however, to avoid oxidation, a shielding tube should be fixed on part of the plasma gas. By measuring flame profiles of Mg, Ca, and Al, the optimum conditions were determined. By choosing hexafluoro acetylacetone as a chelating agent, the separation of rare earths by gas chromatography was made on the various packings and the supports, however, except in the case of Sc, the separation was not satisfactory. (NSA of Japan)

Radiometric Procedures

Refer also to abstracts 5648, 5934, and 5972.

5599 (AERE-R-5864) INVESTIGATION OF THE DISTRIBUTION OF RADIOACTIVE FISSION PRODUCT NUCLEI IN IRRADIATED FUEL SPECIMENS BY PRECISION GAMMA-RAY SCANNING. Banham, M. F.; Causer, R.; Fudge, A. J.; Murphy, L. (Atomic Energy Research Establishment, Harwell (England)). Oct 1968. 36p. Dep. CFSTI (U. S. Sales Only). UK 8s. 0d.

A technique is described, which enables the distribution of gamma emitting radioactive fission product nuclides in irradiated

fuel specimens to be determined. The gamma rays from a selected area of the prepared specimen, obtained by suitable collimation, are detected and resolved by means of their energies. The specimen is then scanned by movement along two axes at right angles to each other and at right angles to the collimator by two electrically pulsed stepping motors. The recording system is driven synchronously by means of two similar motors. A system was devised to represent the variations in the distribution of the intensity of an individual fission product nuclide in the specimen by means of a colour mosaic. This picture is obtained by means of a special colour camera which is described. Examples of specimens scanned in this way are shown, together with the effects of some of the variable parameters in the system. (auth)

5600 (AERE-R-6163) AN IMPROVED METHOD FOR THE DETERMINATION OF PLUTONIUM BY ALPHA COUNTING. Wood, A. J.; Milner, G. W. C. (Atomic Energy Research Establishment, Harwell (England)). Aug 1969. 9p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

An improved method for the determination of plutonium is described in which aliquots of sample solutions for the preparation of sources for alpha counting are accurately dispensed from an Agla microburette using a stepping motor drive for the plunger. Batches of sources are prepared from each sample solution, and a total number of counts in excess of 5×10^5 are recorded for each source. The method was used to determine the plutonium content of a series of uranium–plutonium binary alloys containing from 0.3 to 5.5% plutonium, with a precision (1 σ) of 0.2%. (auth) (UK)

5601 (BMwF-FBK-69-34) MEASUREMENT OF THE SOLUTE CONCENTRATIONS AT THE INTERFACE OF TWO LIQUIDS BY THE LIQUID SCINTILLATION TECHNIQUE. Blaschke, H. G. (Technische Universitaet, Hanover (West Germany). Institut fuer Technische Chemie). Oct 1969. 47p. (In German). Dep. CFSTI (U. S. Sales Only).

At the interface of two-phase systems consisting of a water solution of a weak β emitter and an organic solvent solution of scintillators luminescent scintillation occurs. The scintillation rate depends on the range of β rays, the specific activity of the water phase, and the surface area of the interface. This surface scintillation can be quenched by suitable substances. The quenching occurs only at the interface on the solvent side and it can be used to estimate the concentration of the quencher at the interface. By application of β emitters with different mean ranges (^{3}H, ^{14}C) it is possible to estimate some points of the concentration gradient of the solute at the interface. (auth)

5602 MODERN ANALYSIS. Kienitz, H. (Forschung Badische Anilin-, Soda-Fabrik AG, Ludwigshafen, Ger.). Angew. Chem. Int. Ed. Engl.; 8: 733-50(Oct 1969).

Modern developments in the field of analysis of inorganic solids, chromatography, structural analysis of organic compounds, data processing in analysis, and automation in and with analytical chemistry are discussed. (P.C.H.)

5603 LOW-LEVEL COUNTING OF ENVIRONMENTAL ^{85}Kr BY LIQUID SCINTILLATION. Shuping, R. E.; Phillips, C. R.; Moghissi, A. A. (Southeastern Radiological Health Lab., Montgomery, Ala.). Anal. Chem.; 41: 2082-3(Dec 1969).

A reproducible liquid scintillation technique, which is considerably more sensitive than the previously described methods, is described for the low-level counting of environmental ^{85}Kr. Because of the large amount of Kr that may be introduced into the solution, the sensitivity of the method is high. The values found are in agreement with those previously reported by Sax et al. (Anal. Chem., 40: 1915(1968)), for the same geographical locations. (P.C.H.)

5604 A NEW PROCEDURE OF LIQUID-SCINTILLATION COUNTING IN PLASTIC BAGS FOR ^{3}H, ^{14}C, AND ^{32}P IN BIOLOGICAL MATERIALS. Gupta, G. N. (Rockefeller Univ., New York). pp 31-8 of Isotopes and Radiation in Soil Organic-Matter Studies. Vienna, International Atomic Energy Agency, 1968.

From Symposium on the Use of Isotopes and Radiation in Soil Organic-Matter Studies, Vienna, Austria. See STI/PUB-190; CONF-680725.

A new technique for combustion of biological materials in plastic bags and radioassay of the combustion products in plastic bags has several advantages over the conventional techniques. A wide variety of biological substances (up to 300 mg of dry weight) can be combusted in O_2-filled bags to yield common combustion products, which, when dissolved in suitable solvents, yield colorless solutions with high and constant counting efficiency, eliminating all quenching problems and their corrections. A small volume of this solution (0.5 to 2.5 ml) is placed in a small plastic bag and the bag is heat-sealed after the addition of scintillation fluid. The sealed bag is then placed in a plastic holder (or wide-mouth snap-cap plastic vial) for counting. This technique yields a higher counting efficiency and lower background than the usual procedure of counting in glass vials. For example: ^{3}H, ^{14}C, and ^{32}P have efficiencies of 27, 80, and 90 to 95%, respectively, with a background of 5 to 8 cpm. The procedure is simple, inexpensive and rapid for radioassay of singly or doubly labeled biological samples. (auth)

5605 REMOTE GAMMA SPECTROMETRY FOR FISSION PRODUCT DEPOSITION STUDIES. Blumberg, R.; Dyer, F. F.; Houtzeel, A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 842(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5606 CAPTURE GAMMA-RAY ANALYSIS. Comar, Dominique (CEN de Saclay, Gif-sur-Yvette, France). Trans. Amer. Nucl. Soc., 12: 503-4(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5607 LITHIUM ISOTOPIC ANALYSIS BY SIMULTANEOUS MEASUREMENTS OF ^{6}Li AND ^{17}N. Wiernik, M.; Amiel, S. (Soreq Nuclear Research Center, Yavne, Israel). Trans. Amer. Nucl. Soc., 12: 518(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5608 THE MEASUREMENT OF ^{236}Pu IN MEDICAL-GRADE ^{238}Pu. Bubernak, J.; Matlack, G. M. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 476-7(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5609 APPLICATIONS OF NONDESTRUCTIVE FUEL ASSAY. Untermyer, S. (National Nuclear Corp., Palo Alto, Calif.). Trans. Amer. Nucl. Soc., 12: 439-40(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5610 ALPHA-SCATTERING EXPERIMENT ON SURVEYOR 7: COMPARISON WITH SURVEYORS 5 AND 6. Patterson, James H. (Argonne National Lab., Ill.): Franzgrote, Ernest J.; Turkevich, Anthony L.; Anderson, Wayne A.; Economou, Thanasis E.; Griffin, Harry E.; Grotch, Stanley L.; Sowinski, Kenneth P. J. Geophys. Res.; 74: 6120-48(15 Nov 1969).

The last three Surveyor missions (5, 6, and 7) included an α-scattering experiment that obtained elemental analyses of surface material at three widely separated locations on the moon. On Surveyor 7, three different samples were analyzed at a terra site near the crater Tycho. These samples are much alike in composition but differ from the mare samples of Surveyors 5 and 6 in their lower content of "iron" (elements approximately of mass 56). The analyses at all three sites are similar to the compositions of some of the most common rocks found on the earth's surface, such as basalts, but are quite different from the compositions of ultrabasic rocks and chondritic meteorites. The analyses at the three sites make possible the prediction of the chemical and physical properties of lunar surface material. The difference between the analyses of the mare and terra samples may contribute to the difference in albedo of these two types of material and may also indicate geological separation of lunar materials of varying density, as has happened on earth. (auth)

5611 RAPID SEPARATION OF NATURAL RADIONUCLIDES BY PAPER ELECTROMIGRATION AND A NEW DETECTION METHOD OF THESE ALPHA EMITTERS BASED ON ALPHA PARTICLE TRACK. Hashimoto, Tetsuo; Iwata, Shiro (Kyoto Univ.). Bunseki Kagaku; 18: 1382-8(Nov 1969). (In Japanese).

Natural radionuclides, such as ^{227}Ac, ^{228}Ra and their daughter nuclides, were subjected to the rapid chemical separation by paper electromigration. The substances containing about 1 μc radionuclides were migrated for 3 min under a potential gradient of 2000 volt/29 cm on the paper dipped with the back ground electrolyte of 0.1 M ammonium formate. The detection of alpha radionuclides of this strip was carried out by using the alpha particle track detector with celluloid film. Alpha irradiated films are etched in 6 N NaOH at 50°C for 15 min and compared with the autoradiographs on x-ray films, and thus the alpha nuclides could be easily distinguished from the beta and gamma nuclides. The decay and growth of alpha track after the separation were used for the identification of alpha emitting nuclides on the strip. The half life of the nuclide was also confirmed from measurements of the number of alpha track obtained from the microscopic observation. From these results, the migration order of elements contained in samples was assigned as follows: Th, Po,

Bi (starting point) <Pb, Ac < Ra < Tl. The method is useful for the chemical investigation of alpha nuclides, such as natural radionuclides and actinide elements. (auth)

Activation Procedures

Refer also to abstracts 5751, 5912, 5974, 6074, and 6294.

5612 (AERE-R-6165) THE DESTRUCTIVE AND NON-DESTRUCTIVE ANALYSIS OF VANADIUM FOR CARBON BY γ ACTIVATION. Hislop, J. S.; Wood, D. A. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1969. 18p. Dep. CFSTI (U. S. Sales Only). UK 3s. 0d.

Approximately 0.25 g samples of pure vanadium were analyzed for carbon at concentrations in the range 10 to 150 ppM (wt/wt) by γ photon activation. Results were obtained by chemical separation of the induced ^{11}C activity and by a coincidence counting technique which does not involve destruction of the sample. Problems associated with the presence of interfering reactions, particularly in the nondestructive technique, are discussed. (auth) (UK)

5613 DETERMINATION OF ACTIVATION CROSS SECTION BY GAMMA-RAY SPECTROMETRY. Ishikawa, Hiroaki (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 6: 587-90(Oct. 1969).

A quick and easy way of determining activation cross sections by the analysis of γ spectra is described. To determine cross sections by this method, it is not necessary to measure the neutron flux density, to undertake any chemical separation process, nor to use enriched target substances. To ascertain the validity of the method, the activation cross section of $^{102}Ru(n,\gamma)^{103}Ru$ reaction was obtained, resulting in the value of 1.37 ± 0.132 barns, which compares well with published data of 1.44 ± 0.16 barns, determined by another method. (auth)

5614 DETERMINATION OF THE CONTENT OF COPPER IN ROCKS BY THE APPLICATION OF PHOTONUCLEAR REACTIONS. Kasymov, A. K.; Masagutov, V. S. (Tashkent State Univ.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 77-8(1969). (In Russian).

The content of copper in rocks was determined by the irradiation of standards and samples with 25-MeV bremsstrahlung. Results were compared with results of spectral analyses on the rocks. Good agreement was obtained. (M.C.G.)

5615 DETERMINATION OF YTTRIUM IN RARE EARTHS BY PHOTON ACTIVATION ANALYSIS. Lutz, G. J.; LaFleur, P. D. (National Bureau of Standards, Washington, D. C.). Talanta; 16: 1457-60(Nov 1969).

The determination of yttrium in the presence of large amounts of the rare earths by the thermal neutron reaction $^{89}Y(n,\gamma)^{90}Y$ is complicated because of frequent problems of sample self-shielding from major constituents of the sample, and the difficulty of separating ^{90}Y, a pure beta-emitter, from other elements that are very similar chemically. A nondestructive photon activation analysis method was developed for this determination. Bremsstrahlung from a 35-μA beam of 35-MeV electrons induces the photonuclear reaction $^{89}Y(\gamma,n)^{88}Y$. Optimum sensitivity is obtained by coincidence counting of the 0.90- and 1.84-MeV gamma rays associated with the decay of ^{88}Y. The detection limit is less than 1 μg of yttrium. (auth) (UK)

5616 ACTIVATION ANALYSIS FOR ESTUARINE TRACER STUDIES. Channell, James K.; Kruger, Paul (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc., 12: 500(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5617 ROUTINE FAST ACTIVATION ANALYSIS. Anders, Oswald U. (Dow Chemical Co., Midland, Mich). Trans. Amer. Nucl. Soc., 12: 503(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5618 NEUTRON ACTIVATION ANALYSIS: SOME NOVEL APPROACHES. LaFleur, Philip D. (National Bureau of Standards, Washington, D. D.). Trans. Amer. Nucl. Soc., 12: 504(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5619 CHARGED-PARTICLE ACTIVATION ANALYSIS. Mackintosh, William D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 12: 504-5(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5620 ANALYSIS OF MEDIEVAL STAINED GLASS BY NEUTRON ACTIVATION. Olin, Jacquelin S. (Smithsonian Institution, Washington, D. C.); Miller, Eric C.; Thompson, Barbara A. Trans. Amer. Nucl. Soc., 12: 492-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5621 DETERMINATION OF SHORT-LIVED TRACE IMPURITIES IN SODIUM METAL BY NEUTRON ACTIVATION ANALYSIS. Gills, T. E.; LaFleur, P. D. (National Bureau of Standards, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 494-5(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5622 NEUTRON ACTIVATION ANALYSIS OF SODIUM AT THE PICOGRAM LEVEL. Becker, Donald A. (National Bureau of Standards, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 495(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5623 NEUTRON ACTIVATION TECHNIQUES FOR LABELING OF INSECTS WITH STABLE ELEMENTS. Gage, S. J.; Richardson, R. H.; Bouchey, G. D. (Univ. of Texas, Austin). Trans. Amer. Nucl. Soc., 12: 495-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5624 NEUTRON ACTIVATION ANALYSIS OF AIRBORNE TRACE ELEMENTS IN THE CHICAGO AREA. Brar, S. S.; Gustafson, P. F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 485-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5625 ACTIVATION ANALYSIS OF BIOLOGICAL SAMPLES FOR TRACE ELEMENTS. Guinn, V. P. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 457(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5626 NEUTRON ACTIVATION OF IODINE EMPLOYING A HIGH-RESOLUTION Ge(Li) DETECTOR. Balcius, J. F.; Linekin, D. M.; Brownell, G. L. (Massachusetts General Hospital, Boston). Trans. Amer. Nucl. Soc., 12: 458(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5627 DETERMINATION OF ORGANIC IODINE IN HUMAN SERUM. Tomlinson, R. H.; Billinghurst, M. W. (McMaster Univ., Hamilton, Ont.). Trans. Amer. Nucl. Soc., 12: 458-9 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5628 MEASURING TOTAL BODY CALCIUM BY IN VIVO NEUTRON ACTIVATION ANALYSIS. Nelp, Wil B.; Murano, Robert; Pailthorp, Keith; Palmer, H. E.; Rich, Clayton; Williams, James L.; Rudd, Thomas G.; Hinn, Gervas (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 12: 459-60(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5629 IN-VIVO NEUTRON ACTIVATION ANALYSIS OF CALCIUM IN MAN. Cohn, S. H.; Dombrowski, C. S.; Fairchild, R. G. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 460(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5630 THE ACTIVATION ANALYSIS EXPERT IN COURT: AN INSIDE VIEW. Guinn, V. P. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 506-7(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5631 IDENTIFICATION OF SAMPLES AND INDIVIDUALS BY MULTI-ELEMENT ACTIVATION ANALYSIS. Coleman, R. F.; Goode, G. C.; Wood, G. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Trans. Amer. Nucl. Soc., 12: 507-8(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5632 NUCLEAR MICROPROBE METHOD (PROMPT NUCLEAR-REACTION ANALYSIS). Ricci, Enzo (Oak Ridge Na-

tional Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 505-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5633 PROBLEMS IN THE USE OF ACTIVATION ANALYTICAL EVIDENCE IN COURT. Maletskos, Constantine J. (New England Deaconess Hospital, Cambridge, Mass.). Trans. Amer. Nucl. Soc., 12: 508(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5634 AVAILABILITY OF STANDARDS FOR ACTIVATION ANALYSIS. Meinke, W. Wayne (National Bureau of Standards, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 509(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5635 PROTON-REACTION ANALYSIS FOR ^{12}C, ^{13}C, AND ^{15}N. SENSITIVITY AND BIOMEDICAL APPLICATION. Ricci, Enzo; Gibbons, J. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 509-10(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5636 EXPERIMENTAL SENSITIVITIES FOR 3-MeV NEUTRON ACTIVATION ANALYSIS. Nargolwalla, S. S.; Niewodniczanski, J.; Suddueth, J. E. (National Bureau of Standards, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 510-11(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5637 DETERMINATION OF CARBON IN METALS BY PHOTON ACTIVATION ANALYSIS. Lutz, G. J.; Masters, L. W. (National Bureau of Standards, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 521(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5638 NEUTRON ACTIVATION ANALYSIS OF STABLE IODINATED (^{127}I) PORCINE INSULIN. Cardarelli, J. A.; Podolsky, S.; Burrows, B. A. (Veterans Administration Hospital, Boston). Trans. Amer. Nucl. Soc., 12: 521-2(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5639 INVESTIGATIONS OF FLUORINE DEPOSITS ON ZIRCALOY SURFACES BY PROTON ACTIVATION. Mackintosh, W. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 12: 540-1(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5640 ANALYSIS OF CONTINUOUS PULSE-HEIGHT SPECTRA. Trombka, J. I. (Goddard Space Flight Center, Greenbelt, Md.). Trans. Amer. Nucl. Soc., 12: 473-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5641 NASA'S COMBINED NEUTRON EXPERIMENT: CAPTURE AND ACTIVATION ANALYSIS TECHNIQUES. Mandler, J. W.; Reed, J. H. (Illinois Inst. of Tech., Chicago). Trans. Amer. Nucl. Soc., 12: 471-2(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5642 INTERPRETATION OF GAMMA-RAY DATA FROM PLANETARY ASSAY PROBES. Preskitt, C. A.; John, J.; Reynolds, G. M. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 471(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5643 NEUTRON ACTIVATION DETERMINATION OF TRACE IMPURITIES IN HIGH-PURITY SELENIUM. Gil'bert, E. N.; Pronin, V. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 2, 168-70(1969). (In Russian).

A 100 to 200 mg Se sample was irradiated, together with standards, with 1.8×10^{13} slow neutrons/cm^2-sec for 8 hrs and cooled for 14 hrs; 10^{-5} g of each metal to be determined was added as carrier; the sample was dissolved in aqua regia and evaporated, and the residue taken up in 10 ml 0.2M HCl. The metals were separated by a series of extractions and back-extractions by using dimethylbenzylalkylammonium chloride, β,β'-dichlorodiethyl ether, and dibutyl thiophosphate as the organic extractants. The separation takes 2 to 3 hr, reproducibility including uncertainty in separation yields (54 to 92% for individual metals) is within 15 to 20%. The resolution of 9% for ^{137}Cs is sufficient for determining the individual metals in the groups from chemical separation. The sensitivity of the determination (in g) was: Ir, Au, 2×10^{-11}; As, Sb, W, Cu, Na, Ga, 1×10^{-10} to 3×10^{-10}; In, Re, Ag, Cd, Pd, Zn, 5×10^{-10} to 2.5×10^{-9}; Pt, 1×10^{-8}; K, 5×10^{-8}; Te, 1.3×10^{-7}; Sn, 3×10^{-7}. (Selenium-Tellurium Abstr.)

5644 ACTIVATION ANALYSIS OF PHOSPHORUS WITH 14-MeV NEUTRONS USING BARIUM AS INTERNAL STANDARD. Ishii, Daido; Jinno, Kiyokatsu (Nagoya Univ., Japan). Kogyo Kagaku Zasshi, 72: 1994-8(Sept. 1969). (In Japanese).

Barium is a good internal standard in 14-MeV neutron activation analysis of P. Since ^{137m}Ba produced by the reaction $^{137}Ba(n,n)^{137m}Ba$, $^{138}Ba(n,2n)^{137m}Ba$ has a similar half-life to ^{28}Al produced by $^{31}P(n,\alpha)^{28}Al$, the activity of the latter is conveniently normalized by that of the former. A straight line calibration curve is obtained for P determination with relative errors less than 4.5% for 52 to 560 mg of P. (NSA of Japan)

5645 STUDY ON METALLURGICAL APPLICATION OF RADIOACTIVATION METHOD. Kobayashi, Masatoshi (Tokyo Univ.). Rep. Inst. Ind. Sci., Univ. Tokyo, 19: 85p.(Nov. 1968).

A series of studies concerning the application of radioactivation techniques to various metallurgical problems are summarized. The main techniques that were discussed are: radioactivation analysis of minor impurity elements or minor constitutent elements in metals and alloys, the autoradiography of these minor elements in cast metals, and the autoradiographic examination of the behavior of these elements during the process of zone refining. Both the principles and applications of these techniques are discussed. Nondestructive activation analysis of the minor impurities in high-purity Al is presented. The possibility of the analysis of γ spectra using γ spectrometry was examined for various combinations of irradiation time and cooling time. The use of chemical separation after adequate irradiation and cooling was found to give more precise analytical results and better sensitivity. The method is applicable to process control of Al refining. Autoradiographic study of the mechanism of purification of Al during the zone refining process is discussed, and distribution curves were determined by activation determination of the minor elements along bar specimens after heat treatment. The activation determination of O by high-energy x rays, tritons, or 14-MeV fast neutrons is discussed. The concentration of O and the thickness of Al layer deposited on Al plate were determined using the (γ,n) reaction by high-energy x rays produced by a betatron. The O content of SAP alloy was determined by the (γ, n) reaction and the (t,n) reaction, in which the latter was provoked by bombarding a mixture of sintered Al powder and LiF powder with thermal neutrons. The bombardment with fast neutrons produced in a Cockcroft–Walton type accelerator allowed the activation determination of O in graphite and pure Al. The results of the study on the segregation of U in steel ingots is reported. The activation determination of B in Mo using protons and deuterons is presented. (NSA of Japan)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 5585, 5602, 5706, 5708, 5728, 5730, 5972, 6196, 6662, and 6931.

5646 (COO-1248-18) ELECTRICAL CHARGING OF SMALL PARTICLES AT LOW PRESSURES. Seventh Progress Report, Particle Technology Publication No. 139. Liu, Benjamin Y. H.; Whitby, Kenneth T. (Minnesota Univ., Minneapolis. Particle Technology Lab.). Nov 1969. Contract AT(11-1)-1248. 8p. Dep. CFSTI.

Studies on low-pressure electrical methods for aerosol charging were continued. By this method the particle size can be determined by using only voltage and pressure measurements. A new mobility analyzer was completed, which will be used for further development of the method. A series of measurements were also begun to determine the mobility of monodisperse latex aerosols as a function of particle size and pressure. (M.C.G.)

5647 (IS-2131) BIBLIOGRAPHY OF DOUBLE LAYER STUDIES AT THE POLARIZED LIQUID METAL/SOLUTION INTERFACE. Broadhead, D. E.; Jordan, J. R.; Hansen, R. S. (Ames Lab., Iowa). Jul 1969. Contract W-7405-eng-82. 116p. Dep. CFSTI.

The 969 references listed cover the period from 1936 to 1968 and are concerned with the double layer at the polarized liquid metal/solution interface. The report consists of three sections: a Bibliography section, an Author Index section, and a Key Word Out of Context Index (KWOC Index) section. The Bibliography section lists the author, the title plus a short abstract, and the source citation for each article. The Author Index lists the authors' names and the reference numbers of their articles. The KWOC Index lists the key words, the reference numbers of the articles in which the key word appears and the first 100 characters of their titles. (auth)

5648 (MLM-1606) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT, APRIL-JUNE 1969. (Mound Lab., Miamisburg, Ohio). 17 Nov 1969. Contract AT-33-1-GEN-53. 28p. Dep. CFSTI.

Pseudo-contact shifts in NMR were used to determine the structure of several uranium (IV) coordination compounds. Single crystals of LiH and LiD were prepared by high-temperature reaction of the elements. In ^{229}Th recovery processes, test extractions of the ^{233}U purification raffinate gave poor and quite variable results. Curie amounts of Po were separated from trace levels of impurities by anion exchange and spontaneous deposition. The gamma spectrum of ^{124}Sb in the range 4.5 to 60 keV was measured with a lithium-drifted silicon detector. Above 60 keV it was measured with a lithium-drifted germanium detector. (M.C.G.)

5649 (UCRL-Trans-10409) INVESTIGATION OF EUROPIUM COMPLEXES WITH SOME β DIKETONES. Temkina, V. Ya.; Bolotnikova, T. N.; Naumova, T. M.; Shmorgun, I. V.; Lastoveskiy, R. P. Translated by A. M. A. Mincer for Univ. of California Lawrence Radiation Lab., Livermore, from Prom. Khim. Reaktivov Osobo Chist. Veshchestv; 8: 136-9(1967). 6p. Dep. CFSTI.

Europium complexes with 1-phenyl-1,3-butanedione, 1,3-diphenyl-1,3-propanedione, and 4,4,4-trifluoro-1-(2-thienyl)-1,3-butanedione (TTA) were prepared, containing water, ammonia, and heterocyclic amines as additional ligands. On the basis of elementary analyses and fluorescence spectral data it was found that, in the presence of piperidine and phenanthroline, Eu forms ternary complexes with 4,4,4-trifluoro-1-(2-thienyl)-1,3-butanedione with the composition $EuTTA_3Pip_2$ and $EuTTA_3Phen$. (auth)

5650 SYNTHESIS AND PROPERTIES OF CERTAIN URANYL AMINOPOLYCARBOXYLATES. Krishnamurthy, Manickam; Morris, Kelso B. (Howard Univ., Washington, D. C.). Inorg. Chem.; 8: 2620-4(Dec 1969).

The uranyl chelates of iminodiacetic acid with a ratio (metal: ligand) of 1:2, of nitrilotriacetic acid with ratios of 1:1 and 3:2, of ethylenediaminetetraacetic acid with ratios of 1:1 and 2:1, and of trans-cyclohexanediaminetetraacetic acid with ratios of 1:1 and 2:1 were prepared and characterized by elemental analyses, infrared spectroscopy, and thermal analyses. Their probable structures are discussed. (auth)

5651 VAPOR COMPLEXES OF URANIUM PENTACHLORIDE AND URANIUM TETRACHLORIDE WITH ALUMINUM CHLORIDE. THE NATURE OF GASEOUS URANIUM PENTACHLORIDE. Gruen, D. M.; McBeth, R. L. (Argonne National Lab., Ill.). Inorg. Chem.; 8: 2625-33(Dec 1969).

The following three reactions were studied spectrophotometrically: (1) $2UCl_4(s) + Cl_2(g) = U_2Cl_{10}(g)$, $\Delta F = 15{,}132 - 15.36T$ cal/mole (450 to 650°K); (2) $UCl_4(s) + \frac{1}{2}Al_2Cl_6(g) + \frac{1}{2}Cl_2(g) = UCl_5 \cdot AlCl_3(g)$, $\Delta F = 8914 - 10.74T$ cal/mole (440 to 630°K); (3) $UCl_4(s) + Al_2Cl_6(g) = UCl_2(AlCl_4)_2(g)$, $\Delta F = 15{,}780 - 15.30T$ cal/mole (600 to 800°K). The volatility ratios $V_r = (P_{UCl_2(AlCl_4)_2}$ in 1 atm of $Al_2Cl_6)/P_{UCl_5}$ are found to be $\sim 10^7$ at 500°K, $\sim 10^4$ at 600°K, and $\sim 10^2$ at 700°K. The partial pressure of $UCl_5 \cdot AlCl_3$ is 34 mm at 500°K, 1 atm of Al_2Cl_6, and 1 atm of Cl_2. Uranium pentachloride was found to vaporize as a dimer molecule. The electronic absorption spectrum of gaseous U_2Cl_{10} was interpreted in terms of two Cl octahedra sharing an edge with U atoms at positions of approximately octahedral symmetry. (auth)

5652 CHEMISTRY OF SUPERHEAVY ELEMENTS AROUND Z = 164. Fricke, B.; Greiner, W. (Univ., Frankfurt am Main). Phys. Lett., 30B: 317-19(Oct. 27, 1969).

With a relativistic Hartree-Fock-Slater calculation the most stable configurations of the elements of the possibly quasistable island around Z = 164 were determined. It is found that the expected noble gas at Z = 168 should not occur, but instead the element Z = 164 should have the properties of a noble gas. (auth)

5653 ELECTRONIC TERMS OF DEUTERATED BENZENE CRYSTALS AND THEIR MIXTURES. Broude, V. L. (Inst. of Solid State Physics, Chernogolovka, USSR). Sov. Phys.-Solid State (Engl. Transl.); 11: 944-9(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1159-67(May 1969).

A detailed analysis of the main parts of the spectra from seven different deutero-substituted forms of benzene crystals and their mixtures led to compilation of a unified table of the absorption bands of all possible binary mixtures in the system. The positions of unsplit terms in the crystal spectra have been found and the shifts in the levels in the molecule during crystal formation evaluated. It is shown that in the crystalline mixtures of isotopic forms of benzene a solution effect is observed, which leads to displacement of low-impurity levels when the isotopic composition of the solvent changes. (auth)

5654 VAPOR PRESSURE ISOTOPE EFFECTS. Hoepfner, A. (Univ., Heidelberg). Angew. Chem. Int. Ed. Engl.; 8: 689-99(Oct 1969).

The vapor pressure isotope effect is a reflection of the thermodynamic relations in the condensed phase. It is possible to explain the observed effects on the basis of intermolecular vibrations, and the frequency shifts of the characteristic vibrations on condensation, though other effects must also be discussed. Information about the thermodynamics of liquids, e.g. about the degree of association or the expected positions of the lattice frequencies, can be obtained from the vapor pressure isotope effect. (auth)

5655 EMF AND VOLTAMMETRIC MEASUREMENTS ON THE U(IV)/U(III) COUPLE IN MOLTEN LiF-BeF_2-ZrF_4. Jenkins, H. W.; Mamantov, G.; Manning, D. L.; Young, J. P. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.). J. Electrochem. Soc.; 116: (Dec 1969).

Studies on the U(IV)/U(III) couple were conducted as part of developing an emf series of measured potentials in molten fluorides. Simultaneously with the emf measurements, a simple voltammetric method was developed for the determination of the U(IV)/U(III) ratio when U(IV) $\gg$ U(III). The U(IV)/U(III) ratio in the same samples was also measured by spectrophotometry. A plot of corrected emf values vs the log of the U(IV)/U(III) ratio (from spectrophotometry) resulted in a straight line that exhibited the theoretical Nerstian slope of 0.153 V (at 500°C). The standard electrode potential determined by extrapolation to a U(IV)/U(III) ratio of unity is -1.480 ± 0.01 V. It was concluded that the voltammetric method is particularly useful in nonaqueous solvents where reference electrodes are frequently not readily available, or the standard potentials may not be known. (P.C.H.)

5656 SOLUTE-SOLVENT INTERACTIONS. Coetzee, J. F.; Ritchie, Calvin D. (eds.). New York, Marcel Dekker, Inc., 1969. 663p. $29.50.

Eight chapters are included; separate abstracts were prepared for 2. The remaining chapters contain information on: heats and entropies of ionization; medium effects and pH in nonaqueous solvents; acidity functions; interactions in dipolar aprotic solvents; selective solvation of ions in mixed solvents; and organoalkali compounds in ethers. A brief list of recommended purification methods for selected solvents is appended. (P.C.H.)

For abstracts of individual chapters see: 5657 and 5658.

5657 SOLVENT ISOTOPE EFFECT ON THERMODYNAMICS OF NONREACTING SOLUTES. Arnett, Edward M. (Carnegie-Mellon Univ., Pittsburgh); McKelvey, Donald R. pp 343-98 of Solute-Solvent Interactions. Coetzee, J. F.; Ritchie, Calvin D. (eds.). New York, Marcel Dekker, Inc., 1969.

Discussion is presented on the water problem and solvent isotope effects and the thermodynamic properties of transfer from H_2O to D_2O. Methods of determining the standard thermodynamic properties of transfer ΔG_t^0, ΔH_t^0, ΔS_t^0, $(\Delta C_p^0)_t$ are reviewed and examples of their application are given along with some precautions. The importance of correctly specifying standard states is discussed and the virtues of using mole fractions or other unitary values stressed. Conventions used in the tabulation are given and the results considered in terms of different properties. The inapplicability of internal pressure or cohesive energy densities to such free energies of transfer is pointed out. The inapplicability of simple electrostatic theories to ΔG_t^0 for salts is discussed along with other approaches to the problem. Most of the results are compatible with the idea that the effects of solutes on D_2O at a given temperature are slightly greater than the corresponding effect on H_2O. Data collected on the thermodynamics of transfer for unreacting molecules and ions from light to heavy water up to August 1967 are tabulated. (P.C.H.)

5658 SOLVENT ISOTOPE EFFECTS FOR EQUILIBRIA AND REACTIONS. Laughton, P. M. (Carleton Univ., Ottawa); Robertson, R. E. pp 399-538 of Solute-Solvent Interactions. Coetzee, J. F.; Ritchie, Calvin D. (eds.). New York, Marcel Dekker, Inc., 1969.

Discussion is presented on: water characteristics and solvent

isotope effects in equilibria and kinetics; ionization of acids; nucleophilic substitution and solvent isotope effects; kinetic solvent isotope effects and acid catalysis; and kinetic solvent isotope effects and base catalysis. The review shows that, from its beginnings 30-odd years ago, the solvent isotope effect has been established on a broad experimental base of results and a network of theoretical deductions for a very wide range of reactions. New applications can be in general confidently explored and examined against this reference framework. (501 references) (P.C.H.)

5659 CHELATING EFFECT OF ORGANIC MATTER AND ITS INFLUENCE ON THE MIGRATION OF FISSION PRODUCTS. Bovard, P.; Grauby, A.; Saas, A. (CEN, Cadarache, France). pp 471-95 of Isotopes and Radiation in Soil Organic-Matter Studies. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on the Use of Isotopes and Radiation in Soil Organic-Matter Studies, Vienna, Austria. See STI/PUB-190; CONF-680725.

Organic matter plays a vital role with regard to the radioisotopes introduced by fallout, irrigation water, or surface storage. The chelating effect of various types of organic matter on fission products is considered. The free functional groups (carboxylic, phenolic) are the cause of the fixation and complexing of radioisotopes. A mean order of complexing was established, which varies in its details depending on the type of organic matter concerned. The order established for humic acids, for example, is Ce > Fe > Mn > Co ≥ Ru ≥ Sr > Cs > I. In the case of fulvic acids this order is considerably more upset and is governed essentially by the functional groups present. A verification is presented of the results obtained for two types of soil: a calcareous alluvial soil and a humo-ferruginous podzol. Organic matter plays an essential part in the movement of fission products in these two types of soil. Fulvic acids bring about the accumulation of fission products in the B_h horizon of the podzol, and appear to be partially immobilized in the calcareous alluvial soil. Leaching of fission products, particularly ruthenium, by heavy rains occurs essentially in the form of fulvates. (auth)

5660 EFFECT OF PARTIAL AND COMPLETE DEUTERATION ON THE PHOSPHORESCENCE LIFETIME OF PHENYLACETYLENE. Laposa, J. D.; Singh, H. (McMaster Univ., Hamilton, Ont.). Chem. Phys. Lett.; 4: 288-90(15 Nov 1969).

Phosphorescence lifetimes measured for C_6H_5CCH, C_6H_5CCD, C_6D_5CCH, and C_6D_5CCD in rigid glasses at 77°K show that deuterium substitution for the single acetylenic hydrogen has almost the same effect as deuterium substitution for all five phenyl ring hydrogens in altering the radiationless deactivation of the triplet state. The involvement of an out-of-plane bending of the hydrogens of the ring and a non-totally symmetric (probably also out-of-plane) vibration of the acetylenic hydrogen in the non-radiative transition is suggested. (auth)

5661 PARAMAGNETIC RESONANCE OF URANIUM(IV)–CUPFERRATE. Miyake, C.; Yoshimura, T.; Imoto, S. (Osaka Univ.). Chem. Phys. Lett.; 4: 275-6(15 Nov 1969).

Paramagnetic resonance in uranium(IV) cupferrate was observed. The spectrum was interpreted by the crystalline field theory with a spin Hamiltonian $\mathcal{H} = \beta gH \cdot S + \Delta_x S_x + \Delta_y S_y$, with $g_\perp \approx 0$, $g_{||} = 2.82 \pm 0.05$, and $\Delta = 0.10 \pm 0.02$ cm^{-1}. Uranium(IV) cupferrate is confirmed to have the structure belonging to the point group D_4. (auth)

5662 BEHAVIOR OF IODINE IN ZIRCALOY CAPSULES. Feuerstein, Horst (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Trans. Amer. Nucl. Soc., 12: 541(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5663 THE CsCl–$BaCl_2$ SYSTEM. Box, W. D.; McHenry, R. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 482-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5664 ISOTOPIC EFFECT IN THE FLUORESCENCE SPECTRA OF URANYL AMMONIUM SALTS. Novitskii, G. G.; Sevchenko, A. N.; Umreiko, D. S. (Minsk State Univ.). Dokl. Akad. Nauk SSSR; 187: 1268-70(1969). (In Russian).

Spectroscopic studies of the binary uranyl salts $(NH_4)_3UO_2(SO_4)_2 \cdot 2H_2O$ and $(NH_4)_2UO_2Cl_4 \cdot 2H_2O$ during the substitution of ^{14}N atoms by ^{15}N revealed three types of oscillations of the NH_4^+ ion. Considering the small probability of transmission of the fluctuation energy between the central UO_2^{2+} ion and the external sphere particle NH_4^+, it was assumed that the intramolecular exchange was the result of collectivization of electron shells of various components of the complex. (R.V.J.)

5665 HIGH-SPEED ANALYTICAL SEPHADEX CHROMATOGRAPHY FOR KINETIC STUDIES: APPLICATION TO HYDROGEN EXCHANGE OF NUCLEIC ACIDS. Hanson, Carl Veith (Stanford Univ., Calif.). Anal. Biochem.; 32: 303-13(Nov 1969).

Refinements of the Englander tritium-Sephadex hydrogen exchange technique made possible billion-fold reductions in the specific activity of tritiated water in as little as 20 sec. This improved high-speed "desalting" technique is discussed in relation to hydrogen exchange studies in DNA as well as in the general context of a tool for kinetic studies. (auth)

5666 KINETIC STUDY OF THE EXCHANGE REACTION BETWEEN THE DIAMINO-CYCLOHEXANE TETRAACETATE COMPLEXES OF RARE EARTH METALS AND Cu^{2+} IONS. Brucher, Erno; Szarvas, Pal (Kossuth Lajos Scientific Univ., Debrecen, Hungary). Magy. Kem. Foly., 75: 405-11(Sept. 1969).

The rates of the exchange reactions were studied as functions of H^+ and Cu^{2+} ion concentration. The activation energies, activation enthalpies, and activation entropies were also calculated from the results of the experiments. The copper-ion concentration did not affect the reaction rates; the hydrogen-ion concentration had a linear effect. Data were presented for La, Ce, Pr, Nd, Sm, Eu, Gd, Th, Dy, Ho, Er, Tm, Yb, and Lu. The various factors contributing to the measured and calculated values were discussed, and the effects of rare earth metal composition were described. Thirty-four references are cited. (JPRS)

5667 CONTINUOUS PROCESS CRYSTALLIZER. Bergeret, Marcel; Bourgeois, Michel; Ladanne, Jean-Marie; Raynaud, Andre. (to Commissariat a l'Energie Atomique). British Patent 1,168,962. 29 Oct 1969. Priority date 9 Mar 1967, France.

A crystallizer is described for continuous operation for the treatment of sublimable, corrosive, toxic, or radioactive materials, such as MoF_6, UF_6; or PuF_6. The crystallizer comprises a cylindrical shell having a vertical axis and a cooled side wall. An inner volume of the shell is connected by leak-tight means to a system for circulating a vapor to be treated by crystallization. A rotary tool is situated entirely within the shell for coaxial scraping of the cylindrical shell. This tool comprises at least one fin whose edge is adapted to move close to the side wall of the shell and is continuously heated to prevent substantial crystallization on the surface of the scraping tool. A collector is provided for the crystals. (B.L.M.)

5668 MECHANISM OF CATHODE AND ANODE POLARIZATION OF URANYL IONS IN A SULFATE SUPPORTING ELECTROLYTE AT DIFFERENT CURRENT DENSITY. Spirin, E. K. Izv. Tomsk. Politekh. Inst.; 164: 217-20(1967). (In Russian).

The mechanism of cathode and anode polarization of uranium in sulfuric acid was studied at various current densities and in a wide range of concentrations of electrolyte. Reversibility of cathode and anode electrolytic processes was determined using a stationary mercury drop electrode. (R.V.J.)

5669 DEUTERIUM ISOTOPE EFFECTS IN THE ACID-CATALYZED HYDRATION OF 1-PHENYL-1,3-BUTADIENE. Pocker, Y.; Hill, Martin J. (Univ. of Washington, Seattle). J. Amer. Chem. Soc.; 91: 7154-8(3 Dec 1969).

The kinetics of the acid-catalyzed hydration of 1-phenyl-1,3-butadiene and the acid-catalyzed dehydration of 1-methyl-3-phenylallyl alcohol were studied in aqueous sulfuric acid and deuteriosulfuric acid starting with both deuterated and nondeuterated substrates. The rate constants obtained can be rationalized by a consideration of the component processes involved in the approach to equilibrium. From such a treatment the isotope effects were calculated as follows. In the forward reaction (hydration) the primary solvent isotope effect is 2.97 and the secondary isotope effect using 1-phenyl-4,4-dideuterio-1,3-butadiene is too small to be observed. In the reverse reaction the combined primary and secondary isotope effect arising from complete deuterium substitution in the terminal methyl group of 1-methyl-3-phenylallyl alcohol is 5.5. These results are shown to be consistent with the previously postulated mechanism for the hydration of 1-phenyl-1,3-butadiene and the dehydration of the adduct. (auth)

5670 MECHANISMS FOR THE ACID-CATALYZED HYDROLYSIS OF VINYL ACETATE AND ISOPROPENYL ACETATE. Noyce, Donald S.; Pollack, Ralph M. (Univ. of California, Berkeley). J. Amer. Chem. Soc.; 91: 7158-63(3 Dec 1969).

In dilute aqueous sulfuric acid, both vinyl acetate and isopropenyl acetate hydrolyze primarily by the same mechanism as ethyl acetate. The alternative ASe2 mechanism, involving rate-determining protonation of the double bond, accounts for less than 0.5% of the rate for vinyl acetate but about 20% of the rate

for isopropenyl acetate in 6% sulfuric acid. In this medium, vinyl acetate in 6% sulfuric acid. In this medium, vinyl acetate is hydrolyzed 30% faster than isopropenyl acetate and 75% faster than ethyl acetate. At higher values of the acidity, the ASe2 mechanism becomes progressively more important with the two mechanisms showing equal rates at about 13% acid for isopropenyl acetate and 50% acid for vinyl acetate. The rate of isopropenyl acetate extrapolated to 60% acid, is about 100 times faster than vinyl acetate at the same acidity and about 1.5 times faster than α-acetoxystyrene. Observed solvent isotope effects (k_{H_2O}/k_{D_2O}) are 0.73 in 6% acid and 2.69 in 59% acid for vinyl acetate; for isopropenyl acetate the values are 1.06 in 6% acid and 3.20 in 40% acid. Effects of methyl and phenyl substitution α to a potential carbonium ion site are discussed. (auth)

5671 GENERAL ACID CATALYSIS OF KETAL HYDROLYSIS. THE HYDROLYSIS OF TROPONE DIETHYL KETAL. Anderson, Edwin; Fife, Thomas H. (Univ. of Southern California, Los Angeles). J. Amer. Chem. Soc.; 91: 7163-6(3 Dec 1969).

The hydrolysis of tropone diethyl ketal was studied in water at 15°C. A pronounced general acid catalysis by the acid species of the buffer can be observed. The rate constant for catalysis by Tris (H^+) is less in D_2O than H_2O ($k_{DA}/k_{HA} = 0.67$). The mechanism undoubtedly involves partially rate-determining protonation by the general acid. Thus, if the carbonium-ion intermediate is of great stability general acid catalysis can be obtained even with ketals of aliphatic alcohols. At pH values greater than 10 the rate of hydrolysis is independent of pH. This pH-independent reaction has a D_2O solvent isotope effect (k_{D_2O}/k_{H_2O}) of 0.86. (auth)

5672 EFFECT OF D_2O ON THE CARBOXYPEPTIDASE-CATALYZED HYDROLYSIS OF O-(TRANS-CINNAMOYL) L-β-PHENYLLACTATE AND N-(N-BENZOYLGLYCYL)-L-PHENYLALANINE. Kaiser, B. L.; Kaiser, E. T. (Univ. of Chicago). Proc. Nat. Acad. Sci. U. S.; 64: 36-41(Sep 1969).

Solvent isotope effects were examined for the action of the zinc-containing metalloenzyme carboxypeptidase A on ester and peptide substrates. The kinetic parameters for the carboxypeptidase-catalyzed hydrolysis of an ester, O-(trans-cinnamoyl)-L-β-phenyllactate, in 0.05 M Tris-DCl buffer containing 0.5 M NaCl at pD 8.07 and 25°C were compared with those obtained from measurements done in 0.05 M Tris-HCl buffer containing 0.5 M NaCl at pH 7.52 and 25°C. A $(k_{cat})^{H_2O}/(k_{cat})^{D_2O}$ ratio of approximately 2 was obtained. The value of the Michaelis constant K_m was unaffected by the change in solvent as was the inhibition constant, K_i, found for the product, L-β-phenyllactate, which is a competitive inhibitor. These results indicate that a catalytic step involving general base catalysis is probably important in the carboxypeptidase-catalyzed hydrolysis of an ester. A similar set of experiments carried out on the peptide substrate, N-(N-bezoyl-glycyl)-L-phenylalanine gave ambiguous results. The role of the zinc ion in the catalytic action of carboxypeptidase A can be considered in the light of these findings. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 5599, 5707, 5722, 5966, 5972, 6002, and 6888.

5673 (BNL–14199) ^{90}Sr OZONE GENERATOR FOR SUB-ppm CONCENTRATION RANGE, MODEL 1 INSTRUCTION MANUAL. Steinberg, Meyer; Dietz, Russell N. (Brookhaven National Lab., Upton, N. Y.). Nov 1969. 28p. Dep. CFSTI.

The ^{90}Sr Ozone Generator was designed to produce ozone in the concentration range from approximately 0.002 to 0.6 ppM by volume of O_3 in O_2 to simulate quantities found in the atmosphere. The beta radiation emitted by ^{90}Sr is absorbed by oxygen with the subsequent production of excited states of oxygen molecules, atoms and ions and the ultimate formation of ozone. The generator is described in detail, and instructions for its calibration, operation, and maintenance are given. (J.G.B.)

5674 (COO–1528-40) RADIOLYSIS STUDIES ON FLUOROCARBONS AND ON REACTIVE INTERMEDIATES. Final Technical Report, September 1, 1965–August 31, 1969. Kevan, Larry (Kansas Univ., Lawrence. Dept. of Chemistry). 10 Nov 1969. Contract AT(11-1)-1528. 16p. Dep. CFSTI.

References are given for research on the radiolysis of fluorocarbons during the four year contract period ending Aug. 31, 1969. General areas of investigation include fluorocarbon radiolysis, energy transfer by rare gas sensitization, charge transfer mass spectrometry of fluorocarbons, ionization cross sections, radiolysis of frozen aqueous solutions, spatial distribution of trapped electrons and radicals studied by paramagnetic relaxation, and models for trapped and solvated electrons in polar matrices. (J.G.B.)

5675 (NP–18061) RADIATION CHEMICAL REACTIONS IN FLOWING CYCLOHEXANE. ENERGY PRODUCED OF SENSITIZING REACTIONS OF DISSOLVED MATERIALS. van Ingen, Jan Willem Frederik (Leiden Rijksuniversiteit (Netherlands)). 1969. 71p. (In Dutch). Dep. CFSTI (U. S. Sales Only).

Thesis.

A study of the effects of mono-olefins on product formation in γ-irradiated cyclohexane is described, using as olefins propylene, 1-butene, 2-pentene, 2-methyl-2-butene, and 2,3-dimethyl-2-butene. In addition, radioinduced cis-trans isomerization of 2-pentene and valence isomerization of norbornadiene to quadricyclene, both in cyclohexane solution were investigated. It is shown that the observed reduction in hydrogen formation from irradiated cyclohexane in the presence of olefins is due to H-atom scavenging by the olefins and also to charge transfer. The contribution of this charge transfer reaction increases with increasing difference in the ionization potentials of cyclohexane and the olefins. The radioinduced cis-trans isomerization of 2-pentene in cyclohexane is described. The results confirm the occurrence of the charge transfer reaction. Valence isomerization of norbornadiene (NBD) in cyclohexane is described. It is suggested that NBD reacts with electrons and that isomerization proceeds via an excited state of NBD, formed by neutralization of NBD^-. Electron capture by NBD is consistent with the observed reduction in hydrogen yield from cyclohexane. The results suggest that isomerization of norbornadiene to quadricyclene may proceed via a singlet excited state of norbornadiene in the absence of aromatic solutes, whereas a triplet mechanism may be involved in the presence of these additives. (auth)

5676 (ORNL–4428) TRANSURANIUM PROCESSING PLANT SEMIANNUAL REPORT OF PRODUCTION, STATUS, AND PLANS FOR PERIOD ENDING DECEMBER 31, 1968. Burch, W. D.; Bigelow, J. E.; King, L. J. (Oak Ridge National Lab., Tenn.). Nov 1969. Contract W-7405-eng-26. 37p. Dep. CFSTI.

The status and the future production plans of the Transuranium Element Production Program at ORNL are reported. The total amounts of transuranium elements processed during the period July 1, 1968, to December 31, 1968, are given. The current sequence of process steps is as follows: a feed solution is prepared by dissolving irradiated targets; the plutonium is recovered using a batch solvent extraction process (Pubex); the transplutonium elements are decontaminated from fission products by countercurrent solvent extraction (Tramex); the americium and curium are separated from the transcurium elements by ion exchange or solvent extraction; the transcurium elements are separated from each other by chromatographic elution with α-hydroxyisobutyrate from a high-pressure ion exchange column; the plutonium, americium, and curium are converted to oxide microspheres, using a sol-gel technique; and the microspheres are fabricated into HFIR targets, by remote means, for reirradiation to produce more transcurium elements. The yield of ^{253}Es from ^{252}Cf irradiations was increased by fabricating the californium into rabbits instead of the usual targets. This type of assembly permits irradiation of any duration while the reactor is at full power. A nondestructive method is being developed for assaying the ^{252}Cf content of neutron sources and californium shipping containers. The values used for transuranium element decay data and for cross-section data in planning irradiation processing cycles, calculating production forecasts, and assaying products are tabulated. (J.G.B.)

5677 (RLO–2014-6) RADIATION CHEMISTRY OF THE AQUEOUS NITRATE SYSTEM. III. PULSE ELECTRON RADIOLYSIS OF CONCENTRATED $NaNO_3$ SOLUTIONS. Daniels, Malcolm (Oregon State Univ., Corvallis). [1969]. 42p. Dep. CFSTI.

Optical absorption spectra and reaction kinetics of transient species in concentrated sodium nitrate and nitric acid solutions were investigated for 0.5 to 6.0 M $NaNO_3$ and 6×10^{-2} to 9 M HNO_3. NO_3 was identified as a transient in concentrated neutral nitrate solutions and is shown to be characteristic of the "direct effect." Yield of NO_3 was constant from pH 4 to 11; it decays by 1st order kinetics strongly dependent on pH. In neutral solution NO_3 is identified; it decays by 2nd order kinetics with $(2k/E) = 1.4 \times 10^5$. NO_2 is also produced by the "direct" effect, and as the yield of NO_3 is intensity-dependent, a mechanism of formation is probably $O + NO_2 \rightarrow NO_3$. In acid solutions, NO_3 is also formed by an "indirect effect" with a rate constant 1st order in NO_3^- and H^+. The reaction is probably $OH + NO_3^- + H^+ \rightarrow H_2O + NO_3$. The yield of NO_3 increases fourfold between pH 1 and 0, and the direct process may be pH dependent. In strongly acid solutions decay of NO_3 becomes 2nd order with $(2k/E) = 2.8 \times 10^6 \cdot [E(NO_3)/E(NO_3)] = 0.5$ at 400 nm and $[E(NO_3)670/E(NO_3)400] = 2.9$. NO_3 is not observed in acid solutions. (auth)

5678 (RLO–2014-8) RADIATION CHEMISTRY AND PHOTOCHEMISTRY PROGRAM. Progress Report No. 3, October 1968–

September 1969. Daniels, Malcolm (Oregon State Univ., Corvallis. Dept. of Chemistry). Contract AT(45-1)-2014. 31p. Dep. CFSTI.

Nitrite and hydrogen peroxide yields in the γ radiolysis of aqueous solutions of $Ca(NO_3)_2$, $CsNO_3$, KNO_3, and $LiNO_3$ are reported and the results considered in terms of electron fractions. Ultraviolet spectra of solutions of $Ca(NO_3)_2$, $CsNO_3$, KNO_3, $LiNO_3$, and $NaNO_3$ were studied at concentrations of 10^{-2}M to the solubility limit. Studies are in progress on the origin of O_2 produced in the photolysis and radiolysis of aqueous nitrate solutions. The photolytic oxidation of ammonia in aqueous solution was studied. Studies on continuous-beam uv photolysis of thymine in alkaline solutions are continuing. Flash photolysis experiments were carried out in order to investigate the spectra and kinetics of transient series involved. (J.G.B.)

5679 (RT/PROT-(69)23) TREATMENT OF WASTE CYANIDE SOLUTIONS BY GAMMA RADIATION. Branca, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 13 May 1969. 42p. (In Italian). Dep. CFSTI (U. S. Sales Only).

An outline is given of the main industrial operations producing liquid cyanide wastes and of the effects on public health and safety involved. A description of available treatments is then outlined. A simple procedure is also described for the purification of cyanide wastes by gamma radiation. The gamma rays destroy cyanides: data are given on the influence of the pH, the CN^- concentration, and of the radiation dose. The economics of the method are discussed, assuming that the nuclear wastes coming from reprocessing plants are utilized as ^{137}Cs radiation sources. (auth)

5680 (UCRL-50747) RADIATION DAMAGE IN LiF. Souers, P. C.; Blake, T. S.; Penpraze, R. M.; Leider, H. R. (California Univ., Livermore. Lawrence Radiation Lab.). 16 Oct 1969. 7p. Dep. CFSTI.

Radiation damage in LiF was studied by irradiating LiF powder with ^{60}Co gamma rays (2×10^7 R/hr) and with 160-keV electrons at very high intensity (4 to 7×10^8 R/hr). The radiation damage was found to be qualitatively similar to that produced in LiH. For both kinds of radiation, gamma rays and electrons, large increases in volume were observed and decomposition of the compound was indicated by motionally narrowed NMR signals from Li metal and F_2 gas. One difference that was noted between the effects of the two kinds of irradiation on LiF was in growth as a function of irradiation temperature. For the gamma irradiation the growth increased with irradiation temperature for the temperature range studied, while for the electron irradiation the growth increased to a maximum at about 100°C and then dropped off to quite low levels at 200°C. (auth)

5681 (UJV-2237-Ch) TELOMERISATION REACTION OF TRIFLUOROCHLOROETHYLENE IN THE SOLUTION OF 2-PROPANOL INDUCED BY GAMMA RADIATION. Chutny, B.; Liska, F.; Dedek, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jun 1969. 34p. (SM-123/4). Dep. CFSTI (U. S. Sales Only).

Studies were made on the radioinduced telomerization of trifluorochloroethylene in 2-propanol as a function of trifluorochloroethylene concentration, γ radiation dose, and temperature. A radiation chemical process, which is technically and economically feasible, was obtained for the preparation of fluorinated alcohols with high yields and conversions up to 90%. Among the other results were the establishment of optimum conditions for the formation of each telomer, a dechloration reaction of a chain nature, preparation of dechlorinated telomers, and solution of equations for the mechanism and kinetics of the radiolysis of the system. (P.C.H.)

5682 RADIATION CHEMICAL STUDIES OF PROTEIN REACTIONS: EFFECT OF AMINO ACIDS ON OPTICAL ROTATION. Nisizawa, Mizuho (Defense Academy, Yokosuka, Japan). J. Appl. Polym. Sci., 13: 2269-76(Nov. 1969).

Monosodium l-glutamate, disodium inosine-5′-monophosphate, disodium guanosine-5′-monophosphate, calcium d-pantothenate, l-arginine, and l-aspartic acid were found to protect the changes in the internal relationships of the atoms in the protein molecule from radiation damage. The behavior of the optical rotation was determined. The empirical equation for the protective effect is given by $[\alpha]_f \lambda b - a \log X$, where $[\alpha]f$ is the final specific rotation of the solution, X is the concentration of the amino acids, and a and b are adjustable constants. (auth)

5683 ANNEALING OF CHEMICAL RADIATION DAMAGE IN POTASSIUM CHLORATE. Mohanty, S. R.; Pandey, V. M. (Utkal Univ., Bhubaneswar, India). Curr. Sci. (India); 38: 563(5 Dec 1969).

Reagent-grade potassium chlorate was recrystallized several times from hot aqueous solution. The crystals were thoroughly dried, first at 110°C for 25 hr and subsequently in a vacuum desiccator over phosphorus pentoxide, and irradiated in sealed glass ampoules at room temperature with 50 Mrad of ^{60}Co γ rays at a dose rate of 0.83 Mrad hr^{-1}. The damage, Cl^-, ClO^-, and ClO_2^- ions, in the irradiated crystals were determined by potentiometric microtitrations. A typical set of results for the disappearance of ClO_2^- by thermal annealing of irradiated potassium chlorate is illustrated. (P.C.H.)

5684 THE EFFECT OF GAMMA RADIATION ON THE CHEMICAL COMPOSITION OF A SOIL SOLUTION. Lozhkina, N. N. (All-Union Research Inst. of Fertilizers and Soil Science, Moscow). pp 525-30 of Isotopes and Radiation in Soil Organic-Matter Studies. Vienna, International Atomic Energy Agency, 1968. (In Russian).

From Symposium on the Use of Isotopes and Radiation in Soil Organic-Matter Studies, Vienna, Austria. See STI/PUB-190; CONF-680725.

When soil is sterilized by gamma irradiation, considerable physico-chemical changes take place within the soil itself. The duration of the radiobiological effect in irradiated soil was determined from the change in chemical composition of a soil solution. Twenty-five per cent saturated soil was irradiated with a ^{60}Co gamma source at doses of 200 and 2000 kR, and then incubated at 26°C for 137 d. The soil solution was separated in a centrifuge at a speed of 7000 rpm. The greatest changes occurred in the soil irradiated at 2000 kR, and it was observed that the pH tended to drop while the soluble phosphoric acid tended to rise. The nitrate content did not change as a result of sterilization of the soil. The ammoniacal nitrogen accumulated under the action of soil enzymes and by the end of the experiment the content thereof had increased by a factor of 5 to 7. The amount of mobile manganese increased severalfold, as compared with the control samples, but only during the first month following irradiation, after which it became insoluble. This can apparently be explained by the participation of manganese in redox processes, which are intensified by ionizing radiation. (auth)

5685 T-FOR-H SUBSTITUTION IN METHANE: A HOT-ATOM REACTION WITH WALDEN INVERSION. Bunker, Don L.; Pattengill, Merle (Univ. of California, Irvine). Chem. Phys. Lett.; 4: 315-16(15 Nov 1969).

Trajectory studies of the hot-atom reactions of tritium with methane were made in which all six atoms were tracked. Abstraction of H by T is a direct reaction, as expected, but T-for-H substitution is a concerted process involving at least four atoms. There are indications that it may proceed with inversion of the methane structure. (auth)

5686 CRYSTAL LATTICE DEPENDENCY OF THE FREE RADICALS FOUND IN IRRADIATED GLYCINE. De Bie, M. J. A.; Braams, R. (Univ., Utrecht). Chem. Phys. Lett.; 4: 331-2 (1 Dec 1969).

The EPR spectra, and hence the stable free radicals, are different for the x- or γ-irradiated α-, β- and γ-crystal forms of polycrystalline glycine. Therefore comparisons of the trideuteroglycine EPR spectrum with the EPR spectra of non-deuterated glycine are open to question. (auth)

5687 CHEMICAL EFFECTS OF NUCLEAR BURNUP ON FAST REACTOR FUELS. Spear, K. E.; Leitnaker, J. M. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 593-4(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5688 RECENT OPERATING EXPERIENCE IN THE TRANSURANIUM PROCESSING PLANT. Burch, W. D. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 851-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5689 RADIATION-INDUCED LUMINESCENCE OF CRYSTALLINE AND GLASS POWDERS. McGarrity, James M. (Harry Diamond Labs., Washington, D. C.); Eubanks, Alfred G.; Silverman, Joseph. Trans. Amer. Nucl. Soc., 12: 510(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5690 OZONE SYNTHESIS IN THE BROOKHAVEN CHEMONUCLEAR IN-PILE RESEARCH LOOP. Beller, M.; Tucker, W.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 498-9(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5691 PULSE RADIOLYSIS STUDY OF ALCOHOLS IN AQUEOUS SOLUTION. Simic, M.; Neta, P.; Hayon, E. (Army Natick Labs., Mass.). J. Phys. Chem.; 73: 3794-3800(Nov 1969).

A detailed pulse radiolysis study of aqueous solutions of methanol, ethanol, isopropyl alcohol, n-, iso-, and t-butyl alcohols, neopentanol, and cyclohexanol was carried out. Optical absorption spectra of some of the transients were measured down to 210 nm. Similar spectra were obtained in liquid methanol, ethanol, and isopropyl alcohol. Absorption maxima of transients were obtained in aqueous solutions of n-BuOH (at 222 nm), i-BuOH (at 225 nm), t-BuOH (at 225 nm), neopentanol (at 238 nm), and cyclohexanol (at 230 nm). In alkaline solutions, dissociation of the α-hydroxyalkyl radicals (·ROH) took place, and the absorption spectra of the transients were considerably broadened. The dissociated form of the transients ($\cdot RO^-$) exhibited higher extinction coefficients and lower decay rate constants as compared to the undissociated form. In oxygenated-solutions absorption spectra with $\lambda_{max} \sim 240$ to 250 nm were observed and are suggested to be due to the organic peroxy radicals ($\cdot O_2ROH$). (auth)

5692 RADIATION-INDUCED ISOTOPIC EXCHANGE IN GASEOUS HYDROGEN–DEUTERIUM MIXTURES. Terao, T.; Back, R. A. (National Research Council of Canada, Ottawa). J. Phys. Chem.; 73: 3884-90(Nov 1969).

Isotopic exchange in H_2-D_2 mixtures induced by γ rays and x rays was studied in static and flow systems at dose rates from about 2×10^{10} to 1×10^{12} eV cc^{-1} sec^{-1}, using very pure reagent gases. Highest yields of exchange were obtained using x rays in a well-baked flow system continuously flushed with equimolar H_2 and D_2 at atmospheric pressure, introduced through Pd thimbles. Values of the ion-pair yield, M/N[HD], as high as 2.37×10^7 were obtained, corresponding to G (exchange) = 1.3×10^8. The exchange was highly sensitive to impurities, which undoubtedly accounted for the much lower values (M/N[HD] = 2×10^4) previously reported. Electric fields applied during the irradiation strongly suppressed the exchange, confirming the ionic chain mechanism. An average rate constant of (3.3 ± 0.5) 10^{-10} cc $molecule^{-1}$ sec^{-1} was estimated for the chain propagation step, $H_3^+ + D_2 \rightarrow H_2 + HD_2^+$ (and its isotopic variants), which is thus shown to be a typically fast proton-transfer reaction. This value was obtained by a method in which the propagation reaction competed with removal of ions by an electric field. The data from three sets of experiments, with $[H_2] = [D_2]$, $[H_2] \gg [D_2]$, and $[D_2] \gg [H_2]$, were indistinguishable after corrections for differences in composition and ion mobility. (auth)

5693 CHEMICAL EFFECTS FOLLOWING $^{14}N(n,p)^{14}C$ IN MAGNESIUM NITRIDE. Finn, Ronald D. (Virginia Polytechnic Inst., Blacksburg); Ache, Hans J.; Wolf, Alfred P. J. Phys. Chem.; 73: 3928-33(Nov 1969).

The reactions of carbon-14 recoil species produced by the $^{14}N(n,p)^{14}C$ nuclear reaction were investigated in magnesium nitride. The major reaction products observed upon dissolution in water are $^{14}CH_4$, $^{14}CN^-$, and $^{14}CN_2^{2-}$. Thermal annealing of the neutron-irradiated magnesium nitride resulted in a sharp drop of the $^{14}CN^-$ and $^{14}CN_2^{2-}$ yields and a new product of $^{14}CH_2=NH$ was observed. In a sample annealed at 500° for 2.5 days, up to 65% of the total ^{14}C activity was found in the latter compound. The product distribution was also found to be a function of the pH of the aqueous solvent used for dissolution. (auth)

5694 ELECTRON SPIN RESONANCE OF IRRADIATED SINGLE CRYSTALS OF L-PHENYLALANINE-HCl. Fasanella, Edwin L.; Gordy, Walter (Duke Univ., Durham, N. C.). Proc. Nat. Acad. Sci. U. S.; 64: 1-7(Sep 1969).

Single crystals of L-phenylalanine-HCl have been observed with electron spin resonance after irradiation with a cobalt 60 γ-ray source. The predominant signals observed are from long-lived benzyl radicals. The results indicate that one form of radiation damage to proteins containing this amino acid is breakage of the carbon–carbon bond to release the benzyl radical from the polypeptide chain. Hyperfine structure due to proton couplings of the two methylene hydrogens and of the hydrogens on the ring of the benzyl radical is observed and analyzed to give the electron spin density on the various carbons. The spin density on the methylene carbon is found to be 0.71; that on carbon $C_{(2)}$, $C_{(4)}$, or $C_{(6)}$ is 0.17. The sum of the spin densities on $C_{(1)}$, $C_{(3)}$, and $C_{(5)}$ is −0.22. (auth)

5695 ELECTRON SPIN RESONANCE STUDIES OF ELECTRON IRRADIATED ALUMINUM OXIDES. Reyes L., J.; Reyes, L., S. A. (Univ. Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis.; 18: 305-21(1969).

The relation between dose and the concentration of paramagnetic species induced by 1.0-MeV electron irradiation in powders of four types of aluminum oxide catalysts was studied by the electron-spin resonance technique. The variation of the concentration with time was determined for several temperatures of storage, and the mean activation energies for the total processes of thermal annealing of the centers were determined in temperature intervals from 20 to 100 and 100 to 150°C. (auth)

5696 NOTE ON THE EFFECT OF γ-IRRADIATION ON THE MELTING BEHAVIOR OF POLYETHYLENE SINGLE CRYSTALS. Takamizawa, Kan'Ichiro; Fukahori, Yoshihide; Urabe, Yoshiko (Kyushu Univ., Fukuoka). Makromol. Chem.; 128: 236-41(17 Oct 1969).

Polyethylene single crystals were prepared from isoamyl acetate solutions, whose thickness was 200 Å. They melted without significant reorganization during the heating process of DTA measurements. Irradiation with doses up to 100 Mrad scarcely affected the melting point and heat of fusion of the crystals. In case of pressed aggregates of the single crystal, the increase of the melting point by irradiation was observed. The effect of irradiation became even stronger with melt-crystallized samples. The increase is interpreted in terms of interlamellar crosslinking. It is possible that the melting point of irradiated single crystals increases if the lamellae are in close contact. (auth)

5697 RADIATION-INDUCED POLYMERIZATION OF N-ETHYLMALEIMIDE. Yamakita, Hiromi; Hayakawa, Kiyoshi (Government Industrial Research Inst., Nagoya, Japan). Kogyo Kagaku Zasshi, 72: 2122-6(Sept. 1969). (In Japanese).

Bulk polymerization of N-ethylmaleimide by γ-irradiation was studied above and below the melting point of the monomer The rate of in-source polymerization in the solid state increased with time. A nonstationary state and a monomolecular termination were assumed in the polymerization at low conversion, and the rate constant of the termination at 38°C was estimated by a graphical method. The polymer yield of the post-irradiation polymerization in the solid state, with the exception of that in the final stage, was expressed by the equation $Y = A \log (1 + Bt)$. Meanwhile, the rate of in-source polymerization in the liquid state was much higher than that in the solid state, and the G(–M) value for the polymerization at 60°C was 70,000. From the x-ray diffraction analysis, it was shown that the polymer formed in the solid state was crystalline, while that formed in the liquid state was amorphous. It is probable that the crystalline polymer has a threo-diisotactic configuration. Copolymerization of methyl methacrylate (M_1) and N-ethylmaleimide (M_2) in the liquid state was also studied, and the values of $r_1 = 1.52$, $r_2 = 0.168$ were obtained. (NSA of Japan)

5698 DECOMPOSITION OF CUPROUS THIOCYANATE BY ELECTRON BOMBARDMENT. Ohno, Shin (Japan Broadcasting Corp., Tokyo). Kogyo Kagaku Zasshi, 72: 2153-5(Sept. 1969). (In Japanese).

Cuprous thiocyanate was decomposed easily by bombardment with a medium-energy electron beam and turned to a dark-colored compound. The speed of decomposition can be modified by the simultaneous irradiation with uv light. Cuprous thiocyanate exhibits a weak photocurrent and is chemically sensitive to light and heat because of the oxidation of Cu(I) to Cu(II). Results of the experiment show that electrons exite the sample photochemically and the effect of light is to emit a secondary electron, which gives rise to photoconductivity. The dark coloration of the compound is mainly due to CuS. (NSA of Japan)

5699 STUDIES ON ELECTRON-BEAM CURING OF UNSATURATED POLYESTER–MONOMER SYSTEMS. 2. Kamiike, Hitoshi; Takahashi, Hiroshi (Nippon Paint Co., Neyagama, Japan). Shikizai Kyokaishi, 42: 149-54(Apr. 1969). (In Japanese).

The effects of resin compositions of unsaturated polyester-monomer systems on electron-beam curing rate were studied. Two polyesters were prepared: maleic anhydride 2 moles, phthalic anhydride 2 moles, phthalic anhydride 1 mole, and propylene glycol 3.3 moles, or fumaric acid 2 moles, phtharic anhydride 1 mole, and propylene glycol 3.3 moles, both with an acid value of 30. The monomers employed were styrene, methyl methacrylate, and acrylonitrile. Dose levels employed were from 1.5 to 9 M rad. The curing rate was dependent on the reactivity ratios between polyester and monomer, and the addition of monomer to polyester was proportional to the concentration of unsaturated acids in the polyester. The presence of additives such as metal soap and redox catalyzer had no appreciable effect on the curing rate. (NSA of Japan)

5700 STRUCTURE AND REACTIVITY OF ORGANIC IONS IN GAS-PHASE RADIOLYSIS. I. THE $C_7H_7^+$ ION FROM TOLU-

ENE, ETHYLBENZENE, AND m-XYLENE. Yamamoto, Yukio; Takamuku, Setsuo; Sakurai, Hiroshi (Osaka Univ.). J. Amer. Chem. Soc.; 91: 7192-4(3 Dec 1969).

A study on the structure of the $C_7H_7^+$ ion and its reactivity with aromatic compounds is presented. Toluene, ethylbenzene, and m-xylene vapors were irradiated with ^{60}Co γ rays and the dimeric products analyzed by gas chromatography. In all cases the corresponding benzylated alkylbenzenes were obtained as the main products. The G values were not appreciably affected by the addition of nitric oxide as a radical scavenger, and it is indicated that the benzylation is a nonradical process. From the results it seems reasonable to assume that a rapid variation of the structure between tropylium and benzyl ion occurs and benzyl ion reacts with aromatic compounds. (D.H.M.)

5701 METHOD OF PREPARATION OF HYDROPHILIC SILICONES BY RADIOCHEMICAL GRAFTING. Laizier, Jacques; Wajs, Georges (to Commissariat a l'Energie Atomique). British Patent 1,170,810. 19 Nov 1969. Priority date 1 Dec 1966, France.

A process for rendering silicones more hydrophilic consists of radioinduced grafting of certain monomers onto an organo-silicone polymers of the general formula, $\left[\begin{array}{c} R' \\ | \\ -Si-O- \\ | \\ R'' \end{array}\right]_n$ in which n is an integer and R' and R'' represent the same or different aliphatic or aromatic hydrocarbon radicals. The silicone is first exposed to ionizing radiation, such as electrons, in an oxidizing atmosphere at a temperature below which the peroxydic product of irradiation decomposes, and then the irradiated body is contacted, at a temperature below which the silicone decomposes, with a monomer such as N-vinylpyrrolidone, allyl alcohol, 2-hydroxyethyl methacrylate, or 3-hydroxy-n-propyl methacrylate. (B.L.M.)

Separation Processes

Refer also to abstracts 5586, 5611, 5643, 5648, 5851, 5862, and 7374.

5702 (AECL-3382) EQUILIBRIUM CONSTANTS FOR GS PROCESS REACTIONS INVOLVING TRITIUM COMPOUNDS. Jackson, D. P. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1969. 19p. Dep. CFSTI (U. S. Sales Only). CAN $0.50.

Since heavy water plants of the GS (Girdler-Spevack) type will likely be used for upgrading, it is necessary to understand the behaviour of tritium in this process. Equilibrium constants were calculated for several tritium exchange reactions involving water and hydrogen sulfide using the statistical partition function method. The effects of phase changes and pressure on the calculated equilibrium constants are considered for conditions relevant to the GS process. (auth)

5703 (ANL-7583) A CONCEPTUAL DESIGN STUDY OF A FLUORIDE-VOLATILITY PLANT FOR REPROCESSING LMFBR FUELS. (Argonne National Lab., Ill.). Jul 1969. Contract W-31-109-eng-38. 277p. Dep. CFSTI.

The potential of reprocessing fast-breeder-reactor fuels by fluoride-volatility methods was evaluated in this plant design concept study. A reference flowsheet designed on the basis of knowledge developed in earlier fluoride-volatility work on light-water-reactor (LWR) fuels includes innovative features, such as continuous processing in slab-shaped fluid-bed reactors for criticality safety and total containment of radioactive and noxious waste gases. The process comprises the following steps: (1) separation of cladding from the fuel by mechanical means, (2) fluorination of the fuel to selectively remove UF_6, (3) fluorination of the residue in a second fluid-bed reactor to recover PuF_6, (4) separation and purification of plutonium by thermal decomposition of PuF_6 to nonvolatile PuF_4, (5) purification of UF_6 by distillation and sorption techniques, and (6) mixing of UF_6 and PuF_6 in the desired proportions for conversion to homogeneous UO_2-PuO_2 material by simultaneous reaction of the UF_6-PuF_6 mixture with steam and hydrogen. A preliminary design and plant layout are presented. A preliminary nuclear criticality analysis of key process vessels and a safety analysis of the plant are included. Key problems that would serve as the basis for a fluoride-volatility R&D program are outlined. (auth)

5704 (ARH-1354) RECOVERY OF Am, Cm, AND Pm FROM SHIPPINGPORT REACTOR FUEL REPROCESSING WASTES BY SUCCESSIVE TBP AND D2EHPA EXTRACTIONS. Boldt, A. L.; Ritter, G. L. (Atlantic Richfield Hanford Co., Richland, Wash.). Oct 1969. Conract AT(45-1)-2130. 49p. Dep. CFSTI.

About 1100 grams of americium (Am), 60 grams of curium (Cm), and 200 grams of promethium (Pm) were successfully recovered from the aqueous wastes produced when the Shippingport nuclear power reactor fuel was processed in the Redox plant. Two solvent extraction processes, extraction with tributyl phosphate (TBP), followed by di-(2-ethylhexyl)-phosphoric acid (D2EHPA), were employed. The aqueous waste solution containing Am, Cm, rare earths (including Pm), other fission products, and a high concentration of aluminum nitrate, was batch-contacted with 50% TBP in a normal paraffin hydrocarbon diluent (NPH) at pH 0 to 0.5. The extracted Am, Cm, and rare earths were subsequently back-extracted from the solvent with a 1M nitric acid solution. Nitrilotriacetic acid and hydroxyacetic acid complexing agents were added to the acid solution and the pH adjusted to 4.0 with sodium hydroxide. The adjusted solution was continuously contacted in pulse columns, with D2EHPA diluted by NPH to extract the Am, Cm, and rare earths away from additional metallic impurities. The product was recovered by back-extracting into 2M nitric acid solution. The product solution was concentrated and excess acid destroyed by denitration with sugar. The overall recovery efficiency for all of the products (Am, Cm, and Pm) was about 85%. (auth)

5705 (DP-1142) CURIUM PROCESS DEVELOPMENT. III-4. EVALUATION OF POTENTIAL HAZARDS FROM CHLORINATION OF AMINES AND AMMONIA. West, D. L.; Hyder, M. L.; Burney, G. A.; Prout, W. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1969. Contract AT(07-2)-1. 24p. Dep. CFSTI.

Studies of the three solvent extraction steps involving a chloride matrix and of the americium-curium hydroxide precipitation step of the Savannah River ^{244}Cm process show that no hazards exist from the formation and accumulation of chloramines. Both alkyl and inorganic chloramines are unstable under process conditions, and were not detected in process solutions. (auth)

5706 (MLM-1608) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: APRIL-JUNE 1969. (Mound Lab., Miamisburg, Ohio). 15 Nov 1969. Contract AT-33-1-GEN-53. 48p. Dep. CFSTI.

Studies on carbon isotope separation included several modifications made to improve the efficiency and dependability of the distillation column for the production of carbon monoxide enriched to ~20% ^{13}CO. A new spacer design was tested in a 24-ft (7.3 m) thermal diffusion column with a tubular electric heater and found to be suitable for use in actual production operations. A procedure was tested which permits the determination of column transport coefficients from transient and steady state concentration data. A seven-stage, 12-column, methane thermal diffusion system produced 96 mole % ^{13}C at a rate of about 0.11 g/day of ^{13}C, or 8.48 ml/hr of methane. Two tube bundle cascades of 23 and 19 columns each were brought into operation for the final step of ^{13}C separation. Progress in the separation of isotopes of Ar, Kr, Ne, and Xe by thermal diffusion methods is noted. Thermal diffusion research included the assembling and testing of collimator assemblies for the molecular beam scattering experiment. The composition dependence of the thermal diffusion factor, α_T, for hydrogen-helium mixtures at 0°C was measured. No anomalous behavior was observed. Mutual diffusion coefficients for helium-argon, helium-neon, and neon-xenon are presented. Self diffusion coefficients for helium from 76.5 to 344.0°K and for krypton from 194 to 1036°K are reported. Progress in low temperature research includes the construction of a new cryostat to measure isotopic vapor pressure ratios. Modifications were made in the helium-3 refrigerator. A separation device was installed in the work space of the ^3He refrigerator for the phase separation of liquid ^3He, ^4He mixtures. A calibrated draw tube on a conventional tweeter dip stick was made for measuring liquid helium contents of storage dewars. (J.G.B.)

5707 (ORNL-TM-2434) SUMMARY OF THE CAMPAIGN DURING JULY 1968 TO PROCESS FOURTEEN IRRADIATED HFIR TARGETS IN THE TRANSURANIUM PROCESSING PLANT. King, L. J.; Collins, E. D. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 43p. Dep. CFSTI.

Fourteen irradiated HFIR targets were processed in the Transuranium Processing Plant (TRU) to recover the transuranium elements. Each target originally contained 8 g of plutonium (95.85% ^{242}Pu), in the form of PuO_2, dispersed in aluminum powder in 35 aluminum-jacketed pellets. Thirteen of the targets had been irradiated since the HFIR first attained full power and had received total exposures of from 37,000 to 41,000 Mwd. Examination of the targets prior to processing disclosed no cladding failures. Purified products contained about 15 g of ^{242}Pu, 5 g of ^{243}Am, 40 g of ^{244}Cm,

1 mg of ^{249}Bk, 6 mg of ^{252}Cf, 30 μg of ^{253}Es, and 7×10^7 atoms of ^{257}Fm. The amount of einsteinium product was nearly ten times the quantity that was previously available. The fermium product was the first usable amount of fermium recovered in TRU. Processing steps were: dissolution of the aluminum using caustic-nitrate solution, dissolution of the actinide oxides using concentrated hydrochloric acid, recovery and purification of unburned plutonium using a batch solvent extraction process (Pubex), decontamination of the transplutonium elements using the Tramex solvent extraction process, and separation of americium and curium from the transcurium elements using a LiCl-based anion exchange process. The transcurium elements were separated and purified using laboratory-scale equipment installed in one of the processing cells. The entire processing campaign was completed in three weeks. Equipment performance was satisfactory; no major problems were encountered. (auth)

5708 (ORNL-TM-2744) APPLICABILITY OF METAL OXIDES TO THE DEVELOPMENT OF NEW PROCESSES FOR REOVING SO_2 FROM FLUE GASES. Cantor, Stanley (TRACOR Corp., Austin, Tex. Oak Ridge National Lab., Tenn.). Oct 1969. 41p. Dep. CFSTI.

Thermodynamic data accumulated in a study of the applicability of metal oxides to the development of new processes for SO_2 removal from flue gases were evaluated. Literary sources, empirical methods used for estimation of thermodynamic properties, and conclusions reported by the study were examined, and recommendations were made concerning them. (J.G.B.)

5709 THE CHEMISTRY OF PROTACTINIUM. VIII. SYNERGISTIC EFFECT OF DI-ISOBUTYL CARBINOL ON THE Pa(V)-TTA-BENZENE SOLVENT EXTRACTION SYSTEM. Suzuki, Shin; Inoue, Yasushi (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 42: 2523-31(Sept. 1969).

For the purpose of understanding the behavior of protactinium in a perchloric acid solution toward TTA–benzene extraction, the effects of diisobutyl carbinol (DIBC) on the extraction was studied. A marked synergism was observed. As a result of a detailed investigation of such things as the effects of the TTA concentration, DIBC concentration, and acidity, the unified mechanism of TTA-benzene and TTA-DIBC-benzene extraction is considered to be a series of successive reactions, with an increase in the DIBC concentration: $PaO_m(OH)_n^{5-2m-n} + 4HT = Pa(OH)_2T_3(HT) + (m + n - 2)H_2O + (5 - 2m - n)H^+$, $Pa(OH)_2T_3(HT) \rightarrow PaOT_3(HT)$ (slow, irreversible); $PaO_m(OH)_n^{5-2m-n} + 4HT + B = Pa(OH)_2T_3(HT)B + (m + n - 2)H_2O + (5 - 2m - n)H^+$, $Pa(OH)_2T_3(HT)B \rightarrow PaOT_3(HT)B$ (slow, irreversible); $PaO_m(OH)_n^{5-2m-n} + 3HT + B = Pa(OH)_2T_3B + (m + n - 2)H_2O + (5 - 2m - n)H^+$, $Pa(OH)_2T_3B \rightarrow PaOT_3B$ (slow, irreversible); and $PaO_m(OH)_n^{5-2m-n} + 3HT + 2B = Pa(OH)_2T_3B_2 + (m + n - 2)H_2O + (5 - 2m - n)H^+$, $Pa(OH)_2T_3B_2 \rightarrow PaOT_3B_2$ (slow, irreversible). The slow, irreversible reaction in each step indicates the irreversible formation of unstrippable species in the organic phase with aging. The absorption spectral measurements gave results consistent with this conclusion. (auth)

5710 WATER PURIFICATION OF THE VK-50 REACTOR BY A FOUR-STEP-EVAPORATOR INSTALLATION. Golubev, E. K.; Baronkin, Yu. F.; Nazarov, A. I.; Chechetkin, Yu. V. Teploenergetika; No. 9, 24-7(Sep 1969). (In Russian).

The design, control, and performance of a four-step evaporation device for the VK-50 boiling reactor water purification is described. A two-step vapor elution by a condensate on a perforated sheet of 5 mm thick stainless steel with 5.5 mm in diameter openings suggested for all apparatuses produced a stable coefficient of reactor waste water equal to 10^4 to 10^5 of the activity of 10^{-2} Ci/l concentrate. The consumption of the condensate produced only a negligible effect on the vapor radioactivity and can be limited to 5% of the installation output. (R.V.J.)

5711 INVESTIGATION OF WATER COOLANT PURIFICATION IN FIRST CIRCUIT OF NOVO VORONEZH POWER REACTOR WITH ION-EXCHANGE FILTERS. Matskevich, G. V.; Klement'eva, E. M.; Plotnikov, I. M.; Ryzanov, O. M. (All-Union Heat-Technology Inst., Moscow). Teploenergetika; No. 9, 11-14(Sep 1969). (In Russian).

Data obtained on the purification of coolant water by ion exchange revealed the changes in waste ionites and indicated means and methods for their regeneration. (R.V.J.)

5712 ESTIMATE OF THE SOLUBILITY OF PROTACTINIUM IN LIQUID BISMUTH. Mailen, J. C.; Ferris, L. M.; Nogueira, E. D. (Oak Ridge National Lab., Tenn.). Inorg. Nucl. Chem. Lett.; 5: 869-72(Nov 1969).

Reductive extraction into liquid bismuth is being evaluated as a method for removing protactinum from molten-salt breeder reactor fuel, $LiF-BeF_2-ThF_4-UF_4$ (71.7–16–12–0.3 mole %). In this process, which would operate at about 600°C, it is desirable that the solubility of protactinium in bismuth be as high as that of thorium, i.e., about 2000 ppM at 600°C. No measurements of the solubility of protactinium in bismuth were previously reported in the literature. In the measurements described, an approximate value of 1200 ppM at 500°C was obtained by first extracting protactinium from molten $LiF-BeF_2$ (66-34 mole %) into bismuth at 600°C under conditions such that the concentrations of other metals in the bismuth were very low, and then cooling the system to effect precipitation of a protactinium-containing solid phase. (auth) (UK)

5713 KINETIC OF LIQUID–LIQUID EXTRACTION OF METALS. Htaik, Than (Arts and Science Univ., Rangoon). Union Burma J. Sci. Technol.: 1: 381-90(Dec 1968).

The kinetics of electrolyte extraction are explained on the basis of film theory. To verify this theory, rate measurements were made on the uranyl sulfate–naphthenic acid/kerosene system at 25°C using a stirred-transfer cell. The rate measurements showed that electrolyte extraction is controlled by a chemical reaction taking place in the main liquid phases near the interface. (auth)

5714 CONTAINMENT OF RADIOIODINE IN THE TRANSURANIUM PROCESSING PLANT. King, L. J.; Yarbro, O. O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 852-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5715 CASTOR AND POLLUX, SHIELDED CELLS FOR SOLVENT EXTRACTION STUDIES. Faudot, Gerard; Bathellier, Andre (CEN, Fontenay-aux-Roses, France). Trans. Amer. Nucl. Soc., 12: 853(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5716 MANAGEMENT OF NOBLE-GAS FISSION PRODUCT WASTES FROM REPROCESSING SPENT FUELS. Perona, J. J. (Univ. of Tennessee, Knoxville); Blomeke, J. O.; Stoddart, W. C. T. Trans. Amer. Nucl. Soc., 12: 449-50(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5717 IMPACT OF LARGE-SCALE PLANTS ON FUEL REPROCESSING. Rodger, Walton A.; Reese, Stanton L. (Nuclear Safety Associates, Rockville, Md.). Trans. Amer. Nucl. Soc., 12: 453(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5718 CONSIDERATIONS RELATING TO SITING OF MIDWEST FUEL RECOVERY PLANT. Carson, A. B. (General Electric Co., Santa Clara, Calif.). Trans. Amer. Nucl. Soc., 12: 453-4(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5719 CONSIDERATIONS RELATED TO SITING OF THE ARCO FUEL REPROCESSING PLANT. Selman, M. (Nuclear Materials and Equipment Corp., Apollo, Pa.); Kiel, G. R. Trans. Amer. Nucl. Soc., 12: 454-5(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5720 SELECTION CRITERIA FOR SITING OF REPROCESSING PLANTS IN EUROPE. Sousselier, Y. (CEN, Fontenay-aux-Roses, France). Trans. Amer. Nucl. Soc., 12: 455(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5721 FUEL REPROCESSING PLANT CONTAINMENT. Nichols, J. P. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 455-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5722 RARE-GAS RECOVERY FACILITY AT THE ICPP. Bendixsen, C. L.; Offutt, G. F.; Wheeler, B. R. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 12: 497-8(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5723 ABSORPTION OF METHYL IODIDE BY SODIUM THIOSULFATE SPRAYS. Postma, A. K.; Hilliard, R. K. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 898-9(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5724 DESORPTION OF IODINE FROM ACTIVATED CARBON. Milham, R. C. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 12: 897-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5725 PRELIMINARY DESIGN OF THE HOT FUEL EXAMINATION FACILITY (HFEF). Swanson, N. J. (Argonne National Lab., Ill.); Ferguson, K. R.; Lindberg, J. F.; Mingesz, D. P.; Watson, R. C.; White, J. R. Trans. Amer. Nucl. Soc., 12: 853-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5726 LIQUID-METAL DECLADDING PROCESSES FOR FAST BREEDER FUEL REPROCESSING. Walsh, W. J.; Pierce, R. D.; Steunenberg, R. K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 445(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5727 REPROCESSING OF SIMULATED FAST BREEDER FUEL (UO_2–20 WT. PERCENT PuO_2) USING FLUORIDE VOLATILITY METHODS. Anastasia, L. J.; Steindler, M. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 446 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5728 U^{4+}–Th^{4+} EXCHANGE BETWEEN MOLTEN FLUORIDE AND OXIDE SOLID SOLUTIONS. Bamberger, C. E.; Baes, C. F. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 446-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5729 SYNTHETIC ACTINIDE ELEMENTS: FROM DISCOVERY TO MANUFACTURE. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 886(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5730 COMPLEXES OF TRIVALENT LANTHANIDES AND ACTINIDES WITH DIALKYL-(PP')-ETHANE-(1,2)-DIPHOSPHONIC AICDS. zur Nedden, P. (Univ., Liege). Z. Anal. Chem.; 247: 236-8(30 Oct 1969). (In German).

Two organophosphorus compounds, dibutyl-(PP')- and dioctyl-(PP')-ethane-(1,2)-diphosphonic acid, were synthesized and their complexing properties for trivalent lanthanides and actinides investigated by means of liquid-liquid extractions. The distribution coefficients of four elements were measured as a function of the concentration of metal ions, diphosphonic acid and perchloric acid, using the radioactive isotopes $^{152/154}Eu$, ^{153}Gd, ^{241}Am, and ^{244}Cm. This study permits the determination of the stoichiometry and the equilibrium constants of the complexes formed. (auth)

5731 PERFORMANCE OF POROUS CELLULOSE ACETATE MEMBRANES FOR THE REVERSE OSMOSIS TREATMENT OF HARD AND WASTE WATERS. Hauck, Andrew R. (City of Ottawa Pollution Control Center); Sourirajan, S. Environ. Sci. Technol.; 3: 1269-75(Dec 1969).

Some performance data of porous cellulose acetate membranes in the treatment of hard water, polluted waters, and sewage waters are presented. Using feed waters containing 300 to 800 ppM hardness (expressed as $CaCO_3$), product waters containing 2 ppM or less could be obtained with 90% product recovery and an average initial flux of 38 gallons per day per ft^2 at 1000 psig. The possibility of producing ultrapure waters by repeated reverse osmosis processing is indicated. The performance of the film for separation of iron, manganese, strontium, and aluminum ions from water is discussed. (M.C.G.)

5732 THE DAUGHTER NUCLIDES OF ^{231}Pa. THEIR SEPARATIONS AND NUCLEAR PROPERTIES. Nakanishi, Takashi; Sakanoue, Masanobu (Kanazawa Univ., Japan). Sci. Rep. Kanazawa Univ., 14: No. 1, 29-38(June 1969).

A simple procedure for consecutive separation of Pa, Th, Ac, Ra, Fr, and Pb from each other was studied by using both anion and cation exchange resin columns. By the proposed method, these elements were obtained in a highly pure and carrier-free state easily after the coprecipitation with $Fe(OH)_3$. That is, by using the oxalate form of Dowex 1 × 8 anion exchange resin and the following conversion of this form to the chloride form, AcX (^{223}Ra) + Ac (^{227}Ac) + AcB (^{211}Pb), RdAc (^{227}Th), and Pa (^{231}Pa) were separated from each other and also from Fe carrier. Then, AcK (^{223}Fr), AcB, AcX and Ac, which were not well separated from each other by the preceding procedure, were separated consecutively on Dowex 50 × 8 cation exchange resin. Both α/γ spectra and decay curves of the separated nuclides are reported as well as nuclear properties. (NSA of Japan)

5733 ISOLATION OF RARE-EARTH ELEMENTS FROM APATITE CONCENTRATE. Golub, A. M.; Mulyarchuk, I. F.; Mal'chevskii, A. I. (Kiev State Univ.). Khim. Prom., No. 1, 3-5(Jan.-Feb. 1969). (In Russian).

An extraction method is described for the isolation of rare earths from HNO_3 extracts of apatite concentrate with TBP, with oxides of rare earths obtained as the final product. The flow sheet includes defluorination (optional), partial neutralization, rare earths extraction with 100% TBP, separation into precipitate of their phosphates from the nonaqueous phase with ammonia water, filtration, and conversion of the phosphates into oxides. The percentage of extraction increases with an increase in the amount of salting-out agent and a decrease in solution acidity. These requirements can be easily met under production conditions by feeding as great an excess of HNO_3 as possible for decomposition of the apatite concentrate and subsequent neutralization of the resultant extract to pH 0.5. Elimination of fluorine from the extract increases the extraction of rare earth elements. However, a great excess of HNO_3 (80% or more) permits a high yield without defluorination. Oxides of rare earth elements can be obtained in an 80.2% yield under laboratory conditions from an extract obtained with 55% HNO_3 (with 100% excess of stoichiometry), with subsequent neutralization with 25% ammonia water to pH 0.5, extraction with 100% TBP and reextraction with ammonia water to pH = 2.8 to 3.0. (JPRS)

5734 METHOD OF SEPARATING ACTINIDES FROM ADMIXTURE AND/OR VARIOUS ACTINIDES FROM EACH OTHER DURING REPROCESSING SPENT NUCLEAR FUELS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,170,128. 12 Nov 1969. Priority date 4 Mar 1966, Germany.

A process for the isolation and/or separation of actinides accruing during the reprocessing of spent nuclear fuels and/or breeder substances comprises reacting the actinide in the form of a halide in a melt with at least one cyclopentadienyl compound having a partially ionogenic structure to form an actinide cyclopentadienyl compound of the formula $Ac(CP)_n$ and recovering the actinide from this compound by fractional sublimation. The preferred compounds are dicyclopentadienylberyllium or dicyclopentadienyltin. (B.L.M.)

5735 PROCESS AND APPARATUS FOR PROCESSING IRRADIATED CERAMIC FUEL ELEMENTS. Manevy, Georges; Matcheret, Georges (to Commissariat a l'Energie Atomique). British Patent 1,171,257. 19 Nov 1969. Priority date 21 Nov 1967, France.

An apparatus and a process are described for separating ceramic fuel material, either oxide, carbide, or nitride of U or Pu, from the cladding material by mechanical means. The fuel elements are cut into short fragments, and the fuel material is separated from the fragments by impact blows from a ballmill for a sufficient time to cause crumbling of the fuel material, which is removed from the can in powdered form. (B.L.M.)

5736 ISOTOPIC FRACTIONATION BETWEEN GASEOUS AND DISSOLVED CARBON DIOXIDE. Vogel, J. C.; Grootes, P. M.; Mook, W. G. (Univ., Groningen, Netherlands). Z. Phys.; 230: 225-38(1970).

The isotopic fractionation between gaseous carbon dioxide and an equilibrated aqueous solution of the gas was measured at temperatures between 0 and 60°C for the carbon isotopes and close to 0°C for the oxygen isotopes. $^{13}C^{16}O_2$ is slightly less, and $^{12}C^{16}O^{18}O$ slightly more soluble than $^{12}C^{16}O_2$, the actual values for the fractionation, ϵ, being $-(1.18 - 0.0041 \cdot t)‰$ (temperature, t, in °C) for the carbon isotopes and about 0.8‰ at 0°C for the oxygen isotopes. A theoretical expression is derived for the vapor-solute equilibrium system by treating it in a similar manner as the pure vapor-liquid system. The calculated isotopic fractionation for carbon dioxide, using data on the pure vapor-liquid system, is in satisfactory agreement with the experimental results. (auth)

5737 AN APPARATUS FOR DISSOLVING URANIUM–ALUMINUM ALLOYS. (to Commissariat a l'Energie Atomique). British Patent 1,170,385. 12 Nov 1969. Priority date 9 Aug 1967, France.

An apparatus is described for the continuous separation of U and Al in U–Al alloys by dissolution of the Al in at least a 5N NaOH solution and separation of U as insoluble oxides with compositions between UO_2 and U_3O_8. The apparatus consists of a substantially

vertical reaction column with means at the upper end for introducing pieces of alloy and an aqueous solution of caustic soda and with a duct at the lower end for extracting the suspension of uranium oxide. A grid is provided for holding back the pieces of alloy. Conduit means are provided for evacuation of the reaction gases, and a grid is provided in the conduit means for bursting foam bubbles. The liquid formed from the bursting bubbles is recycled by a tube back to the column. (B.L.M.)

5738 METHOD OF REDUCING A RADIOACTIVE WASTE SOLUTION TO DRYNESS. Thompson, Thomas K. (to U. S. Atomic Energy Commission). U. S. Patent 3,479,295. Nov. 18, 1969.

In order to reduce a radioactive waste solution or slurry to dryness, the solution or slurry is evaporated and the resulting solids are calcined in a fluidized bed, which is heated by burning a hydrocarbon fuel in the bed in the presence of nitrate ions. (AEC)

5739 TRILAURYLAMINE EXTRACTION OF PLUTONIUM WITH PRECIPITATION IN OXALIC ACID. Bathellier, Andre (to Commissariat a l'Energie Atomique). U. S. Patent 3,476,787. Priority date Aug. 25, 1964, France.

Plutonium is extracted in an organic phase consisting of trilaurylamine diluted in a solvent and reextracted by H_2SO_4. The Pu is then precipitated in the presence of oxalic acid, and mother liquor from the precipitate is recycled directly at the level of Pu purification by trilaurylamine extraction without previous evaporation. (Offic. Gaz.)

5740 USE OF REDOX RESINS IN INORGANIC CHEMISTRY. Manecke, Georg; Kossmehl, Gerhard; Hartwich, Guenther; Gawlik, Regina (Freie Univ., Berlin). Angew. Makromol. Chem.; 2: 86-98(30 Apr 1968). (In German).

Ag, Cu, Te, and Se were precipitated from aqueous solutions by a redox resin containing the system anthraquinone–anthrahydroquinone. Ag, Cu, and Te were dissolved in 1 N nitric acid. Se was dissolved in a solution of KCN. This resin was able to alter the valences of variable-valence ions ($UO_2^{2+} \rightarrow U^{4+}$; $VO_2^{-} \rightarrow V^{3+}$). It was possible to produce H_2O_2 solutions up to a concentration of 1.3 N in a continuous process with a resin made by condensation of hydroquinone and phenol with formaldehyde. (auth)

5741 5-HYDROXY-1-ARYL-4-PYRIDONE-2-CARBOXYLIC ACID ESTERS AS CHELATING AND EXTRACTING AGENTS. I. EXTRACTION AND SEPARATION OF TANTALUM(V) AND NIOBIUM(V) FROM OXALATE SOLUTIONS. Herak, M. J.; Janko, M.; Blazevic, K. (Univ. of Zagreb). Croat. Chem. Acta, 41: 85-91(1969).

The extraction of niobium and tantalum from oxalate solutions has been studied using the esters of 5-hydroxy-1-aryl-4-pyridone-2-carboxylic acid as extractants. The influence of the concentration of hydrochloric, sulfuric, hydrofluoric, and oxalic acids on the extraction of niobium and tantalum has been investigated. The dependence of the extraction of these metals upon the concentration of the extractant in the organic phase was also studied. A procedure for the separation of niobium from tantalum directly from oxalate solution is described. The radionuclides ^{95}Nb and ^{182}Ta were used for the determination of the distribution coefficients. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 5659, 5684, 5718–5720, 5764, 5769, 5941, and 6808.

5742 (USGS–474-43) PHYSICAL PROPERTIES OF 16 SURFACE ROCK SAMPLES FROM SOUTHEASTERN AMCHITKA ISLAND, ALASKA. Amchitka-4. Quinlivan, W. D. (Geological Survey, Denver, Colo.). Sep 1969. Contract AT(29-2)-474. 5p. Dep. CFSTI.

Sixteen rock samples are described as to their source localities on Amchitka Island and their physical properties. These preliminary data should prove useful in predicting probable variations of some properties of Amchitka rocks that are pertinent to engineering and seismic problems. (auth)

5743 (USGS–474-52) PRELIMINARY LITHOLOGIC LOG OF DRILL HOLE UAe-2 FROM 0 TO 3,580 FEET, AMCHITKA ISLAND, ALASKA. Snyder, Richard P. (Geological Survey, Denver, Colo.). Sep 1969. Contract AT(29-2)-474. 3p. Dep. CFSTI.

Drill hole UAe-2 is located at site B in the sourth-central part of Amchitka Island. Ground elevation at the drill hole is 129.5 feet above mean sea level. The drill-hole interval from 0 to 3,580 feet is the thickness of the Banjo Point Formation at the site. A graphic representation of the lithology and selected geophysical logs are given. The rocks of the Banjo Point Formation are mainly basaltic breccias intruded by basaltic or andesitic sills, and the formation is believed to be of submarine origin. (J.C.W.)

5744 ON THE USE OF PULSED NEUTRON–NEUTRON LOGGING FOR SEPARATING OIL-BEARING AND WATER-BEARING FORMATIONS. Konoplev, Yu. V. Geofiz. App., No. 36, 165-7(1968). (In Russian).

In separating oil-bearing and water-bearing formations when the salinity of the formation waters is low, it is necessary to take into account the variation in hydrogen content of the section, using geophysical methods. The possibility of estimating the hydrogen content of formations on the basis of the integral curve of pulsed neutron-neutron logging and simultaneously determining the apparent average lifetime of thermal neutrons was examined, and the requirements for the recording apparatus are formulated. To separate oil- and water-bearing formations, the relationship of the relative readings of the integral curve and apparent average lifetime of the neutrons is used, which avoids the necessity of using a supplementary method in the well investigation. (Geophys. Abstr.)

5745 DEVICE FOR INVESTIGATING THE CEMENT COLLAR BEHIND THE COLUMN OF OIL AND GAS WELLS. Bernshtein, D. A.; Kolesnichenko, V. P.; Trufanov, V. V. Geofiz. App., No. 35, 123-9(1968). (In Russian).

A new device for investigating the cement collar of a well is described, which is based on the recording of scattered gamma radiation and is called a borehole gamma defectometer. It is free to a considerable extent of the defects present in the cement meter and gives more complete and more accurate information on the state of the cement collar. The operating principle consists of the recording of the curve of intensity of scattered gamma radiation on the perimeter of the well, using an evenly rotating directional gamma-gamma logging sonde which is either continuously moved along the well stem or is set at points at chosen intervals. (Geophys. Abstr.)

5746 ENVIRONMENTAL TRITIUM IN CONJUNCTIVE USE STUDIES OF CONTINENTAL RIVER SYSTEMS. Sharp, John V. A.; Westphal, Jerome (Univ. of Nevada, Reno). Trans. Amer. Nucl. Soc., 12: 501(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5747 NATURAL ^{32}Si FOR AGE-DATING GROUND WATERS: A NEGLECTED POTENTIAL. Schink, David R. (Isotopes, A Teledyne Co., Palo Alto, Calif.). Trans. Amer. Nucl. Soc., 12: 500(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5748 RADIOTRACER STUDIES OF WATER FLOWS IN WATER TREATMENT PONDS. Fries, B. A. (Chevron Research Co., Richmond, Calif.). Trans. Amer. Nucl. Soc., 12: 501-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5749 DIFFUSION OF TRITIATED MOISTURE FROM A STREAM. Daly, James C.; Gabay, Jack J. (New York State Dept. of Health, Albany, N. Y.). Trans. Amer. Nucl. Soc., 12: 899-90(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5750 THERMAL UTILIZATION OF RIVERS. Fager, John F. (Omaha Public Power District, Neb.); Wittke, Dayton D. Trans. Amer. Nucl. Soc., 12: 817-18(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5751 GROUND WATER TRACING WITH POST-SAMPLING NEUTRON ACTIVATION. Schmotzer, Jack K.; Jester, W. A. (Penn State Univ., University Park). Trans. Amer. Nucl. Soc., 12: 502(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5752 REGULATIONS CONCERNING THERMAL DISCHARGES TO THE NATION'S WATERS. Burd, Robert S. (Dept. of Interior, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 815(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5753 GEOPHYSICAL IMPLICATIONS OF PHOTONUCLEAR PRODUCTION OF ARGON ISOTOPES. Larson, R. E.; Gordon, C. M. (Naval Research Lab., Washington, D. C.). J. Geophys. Res.; 74: 6023-5(15 Nov 1969).

Measurements of the relative abundances of argon isotopes and their relationship to potassium have become widely used for geological applications. It is usually assumed in such techniques that the only sources of ^{40}Ar are the radioactive decay of ^{40}K, atmospheric contamination, and, in the case of meteoritic material, spallation reactions caused by high-energy protons. The possibility of an additional source of argon isotopes, i.e., photonuclear production by γ rays acting on natural calcium was investigated. The cross section for production of ^{44}Ar and ^{43}Ar by (γ,α) reactions on ^{48}Ca was measured. Extrapolation of this result indicated an upper limit of the order of 0.1 millibarn for the cross section of the $^{40}Ca(\gamma,\alpha)^{36}Ar$ reaction with ~50 MeV γ rays. This small cross section precludes the formation of significant quantities of ^{36}Ar to alter age determinations. (auth)

Meteorology

Refer also to abstracts 5718–5720.

5754 ^{35}S AND ^{7}Be IN GROUND-LEVEL AIR AT ASPENDALE. Hicks, B. B. (CSIRO, Aspendale, Australia). Nature (London), 224: 172(Oct. 11, 1969).

It is stated that although calculated ^{7}Be cosmic ray production rates are in general confirmed by measurements, ^{35}S has been found to be about six times more abundant in rainfall than predicted by cosmic ray spallation theory. The monthly mean concentrations of these isotopes in the air at Aspendale (38°S) are reported for Sept. 1967 to May 1968. Corrections of ^{7}Be values were made for ^{103}Ru from French atomic weapons tests. The average ^{7}Be concentration found was 65 pCi/KSCM; and the measured ratio $^{7}Be/^{35}S$ was about 80, compared with the predicted value of about 90 from spallation theory. The results confirm spallation production and support a suggestion of probable production of ^{35}S in nuclear explosions. (UK)

5755 CONTRIBUTION TO THE DETERMINATION OF THE AVERAGE DELAY TIME OF NATURAL AEROSOLS: METHOD AND PRELIMINARY RESULTS. Schreiber, Hermann; Woerner, Fritz (Univ., Stuttgart). Arch. Meteorol., Geophys. Bioklimatol., Ser. A, 18: 75-86(1969). (In German).

The concentration of Rn decay products, which are attached to aerosols, in the layers of air near the ground varies with many parameters. The determination of the average delay time of the aerosols from the disturbed equilibrium of radioactivity of the attached RaD and RaE activities is reported. The experimental method used is discussed, especially the treatment of the glass fiber filter which is used for the collection of the aerosols and the chemical separation of Bi and Pb. In this process care is

given to the use of the precipitated daughter products of thoron as radioactive tracers in the RaD–RaE analysis. Some results of the measurements are presented. The importance of simultaneous ^{90}Sr measurements of the filter samples for the estimation of the stratospheric RaD component is stressed. The aerosol particles were also examined by electron microscopy. (BBB)

5756 MEASUREMENTS AND ANALYSES OF RADIOACTIVE AIRBORNE DEBRIS FROM THE NUCLEAR TEST EXPLOSION. Igarashi, Shunji. Nippon Genshiryoku Gakkaishi, 11: 606-11(1969). (In Japanese).

The radioactive airborne debris that reached the sky over Japan in the wake of the 7th Chinese nuclear test explosion of December 24th, 1967, were collected with the use of an airborne dust sampler mounted on aircraft and subjected to gross β-activity measurement, γ spectrometry, and mass spectrometry. The concentration of radioactive debris in the air stood at about 18,000 pCi/m^3 on December 25, from where it decreased gradually to reach a level below 1 pCi/m^3 on December 28, the level prevalent before the test explosion. Short-lived radionuclides such as ^{239}Np, ^{143}Ce, ^{132}I, and ^{99}Mo were clearly detected by γ spectrometry, but the presence of ^{237}U was not confirmed. The elementary composition of the debris collected shortly after the explosion was not substantially different from those collected at normal times. The content of lithium, however, was about 120 times as high as the level before the test explosion. The isotopic abundance ratio of ^6Li was 14.6%, about twice the natural isotopic abundance ratio. (auth)

5757 SPONTANEOUS UNIPOLAR CHARGE ACQUISITION BY β-ACTIVE HOT AEROSOL PARTICLES. Ivanov, V. D.; Kirichenko, V. N. Dokl. Akad. Nauk SSSR, 188: 65-8(Sept.-Oct. 1969). (In Russian).

Previously V. D. Ivanov et al. (Dokl. Akad Nauk SSSR, 182: 2 1968)) showed that α-active aerosol particles with radioactivity reaching 10^{-11} Ci have the ability of acquiring stationary positive charges produced by α-decay accompanied by secondary electron emission. An attempt was made to study the regularities of such a charge for β-active aerosol particles. (R.V.J.)

5758 MODEL OF ATMOSPHERIC DISPERSION IN AN URBAN ENVIRONMENT. Roberts, John J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 816-17(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5759 EXPERIMENTAL CONTROL PROGRAM FOR FOSSIL FUEL PLANTS DURING AIR POLLUTION INCIDENTS. Croke, Kevin G. (Northwestern Univ., Evanston, Ill.); Kennedy, Allen S. Trans. Amer. Nucl. Soc., 12: 817(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5760 EXCESS ATMOSPHERIC ^{210}Po: POLLUTANT OR NATURAL CONSTITUENTS? Martell, E. A.; Poet, S. E. (National Center for Atmospheric Research, Boulder, Colo.). Trans. Amer. Nucl. Soc., 12: 484-5(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5761 TRACKING AND SAMPLING RADIOACTIVE CLOUDS FOR HUNDREDS OF MILES. Crawford, Todd V. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 12: 486(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5762 SOME NUCLEAR TECHNIQUES FOR ATMOSPHERIC DILUTION AND DISPERSION STUDIES. Nielsen, Julian M. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 486-7(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5763 URBAN MICROMETEOROLOGY. Hanna, Steven R. (Air Resources Atmospheric Turbulence and Diffusion Lab., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 815-16(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5764 SOURCES AND SINKS OF AIR POLLUTION TRACE METALS IN LAKE MICHIGAN. Winchester, John W.; Robbins, John A.; Dams, Richard F. (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 12: 484(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5765 RADIOACTIVE FALLOUT IN RAINWATER DURING MONSOON 1966. Khaing, U. Chit; Pe, U. Hla (Arts and Science Univ., Rangoon). Union Burma J. Sci. Technol.: 1: 591-3 (Dec 1968).

Data on radioactive fallout in rainwater measured during the 1966 monsoon are reported. An increase in total beta activity was observed during the period from May 23 to June 23. The maximum level of total beta activity was 107.3 picocuries per liter. (auth)

Mineralogy and Exploration

Refer also to abstract 5781.

5766 DIE PETROLOGIE UND DIE URANLAGERSTAETTEN DES KOLI-KALTIMOGEBIETS IM FINNISCHEN NORDKARELIEN. (Petrology and Uranium Deposits in Koli-Kaltimo Region in Finnish Northern Karelia). Piirainen, Tauno. Bulletin de la Commision Geologique de Finlande. Otaniemi, Finland, Geological Research Institute, 1968. 99p.

Particular stress is given to the importance of petrological basis in understanding the occurrence of ore deposits. The processes of sedimentation, magmatic development, and deformation are particularly emphasized. Position of the environment of uranium deposits in Karelian-svecofinnish orogenic cycle was studied. Uranium deposits in Koli-Kaltimo region were found to be in fissures and fracture zones in psephitic-arenyte-pelite-accumulations of evolutionary transgressive early-orogenic sedimentary phase, cut by initial magmatic tholeiitic and spilite veins, in a horizon of orthoquartzite layer as bedding nests under arkosic quartzite, and close to this horizon connected with metadiabase. The former represent primary ores, uranium, and possibly also vanadium concentration which is due to ferrihydroxide adsorption from underground water; the latter regenerated deposits, uranium and vanadium concentration of which can be referred to the above-mentioned primary deposits. (auth) (Finland)

Oceanography

5767 VOLUME OF THE CONTAMINATED REGION FROM A CONTINUOUS POINT SOURCE IN THE OCEAN. Chambre, P. L. (Univ. of California, Berkeley); Schrock, V. E.; Mikhail, S. Z. Trans. Amer. Nucl. Soc., 12: 422-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Seismology

5768 COMMENTS ON A PAPER BY C. WRIGHT AND K. J. MUIRHEAD, "LONGITUDINAL WAVES FROM THE NOVAYA ZEMLYA NUCLEAR EXPLOSION OF OCTOBER 27, 1966, RECORDED AT THE WARRAMUNGA SEISMIC ARRAY." Bolt, Bruce A.; Qamar, A. (Univ. of California, Berkeley). J. Geophys. Res., 74: 6049-51(15 Nov 1969).

The original measured data recorded at the Warramunga Seismic Array on P wave velocity measurements from the Novaya Zemlya nuclear explosions of October 27, 1966 were examined and correlated with a hypothesis that the precursory waves were reflections of PP type from the undersides of physical discontinuities in the upper mantle. Calculations of wave motion slowness were compared with measured values, and limitations of this hypothesis are discussed. (L.C.L.)

ENGINEERING

Nuclear Explosions

5769 (NVO–1229-108) RADIOACTIVITY IN THE HYDROLOGIC ENVIRONMENT: PROJECT RULISON. FINAL PRESHOT REPORT. Nork, William E. (Isotopes, Inc., Palo Alto, Calif.). 13 Aug 1969. Contract AT(29-2)-1229. 13p. (PNE-R–9). Dep. CFSTI.

The assumptions and methods used to make a pre-shot estimate of the radioactive contamination of site ground waters following the Rulison Event are presented. Source term concentrations for tritium and strontium-90 were assumed to be 6×10^{-2} to 2×10^{-1} μCi/ml and 4×10^{-2} to 1×10^{-1} μCi/ml, respectively. Assumption of high but credible water movement rates and reasonable retardation effects, indicated that neither tritium or strontium-90, for example, would move more than a few miles before decay or dilution to below CG levels. In the unlikely event of mass movement of radioactivity upwards to the land surface, transport of nuclides rates might exceed those at depth, but greater-than-CG levels of activity were not expected for any known water use point. (L.C.L.)

5770 TIME-DEPENDENT NEUTRON ESCAPE FROM NUCLEAR EXPLOSIONS. Dupree, S. A. (Naval Weapons Evaluation Facility, Albuquerque, N. Mex.); Sandmeier, H. A.; Hansen, G. E.; Engle, W. W. Jr. Trans. Amer. Nucl. Soc., 12: 722-3 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5771 RULISON STIMULATES PROTESTS; AND, HOPEFULLY, GAS. Nucl. News, 12: No. 10, 20-1(Oct. 1969).

The Rulison Event in Project Plowshare, a 40 kt nuclear explosion detonated September 10, 1969 at a depth of 8500 ft in a sandstone formation near Rifle, Colorado, is described in terms of its significance to future natural gas production stimulation projects and for the repercussions it caused among conservationists. An evaluation of the test will be made in early 1970. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 5667, 5673, 5737, 6489, 6500, 6610, 6798, and 6799.

5772 (K–1773) DAMPING IN A COMPOSITE BEAM MODEL. Corley, J. E. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 16 Dec 1969. Contract W-7405-eng-26. 26p. Dep. CFSTI.

The damping characteristics of a steel-concrete composite floor beam have been determined with the use of a $\frac{1}{5}$-scale model. The critical damping ratio, β, at the first bending mode for this construction was found to be 0.0332 with a standard deviation of 0.00375. By loading the beam with lead bricks, a curve of the first bending frequency as a function of load was obtained and from this, using model predictive equations, a fundamental frequency for the prototype floor beam was estimated to be 11.6 Hz. A technique was developed which evaluates the parameters of natural frequency and damping ratio, using a nonlinear least squares curve fit routine of a transmissibility curve. (auth)

5773 (RFP–1310) CROSSED-FIELD DISCHARGE DEVICE FOR HIGH RATE SPUTTERING. Mullaly, James R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 13 Nov 1969. Contract AT(29-1)-1106. 11p. Dep. CFSTI.

A high rate sputtering device is described which utilizes a hemispherical concave cathode (target) and a crossed-field region created by superimposing a cusp magnetic field on the electric field of the cathode. Metal has been sputtered from the cathode at rates up to 2.2 mils per hour for copper under these conditions. Parameters affecting the discharge, and the deposit profiles and rates are discussed. (auth)

5774 (WAPD-TM–650) FUGIT-1: A COMPUTER PROGRAM FOR THE DYNAMIC RESPONSE OF ELASTIC STRUCTURES WITH NONLINEAR CONSTRAINTS AND DAMPING. Friedrich, C. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1969. Contract AT(11-1)-Gen-14. 28p. Dep. CFSTI.

The FORTRAN-4 computer program FUGIT-1 determines the transient shock and vibration response of an elastic structure mounted on a rigid base whose history of acceleration vs time for all six degrees of freedom is known. The structure may have nonlinear damping and constraints, such as misaligned clearances and pre-loaded bolts. Principal and von Mises stresses may be determined at 20 locations, and a frequency spectrum analysis may be made for 8 variables. The description includes data input instructions and 2 worked examples. (auth)

5775 DESIGN OF HEATED CYLINDRICAL PRESSURE VESSELS IN TRANSIENT CREEP. Kraus, H. (Rensselaer Polytechnic Inst., Troy, N. Y.); Siddall, W. F.; Lawton, C. W. Trans. Amer. Nucl. Soc., 12: 830(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5776 MANPOWER AVAILABILITY AS SEEN BY THE ENGINEER-CONSTRUCTOR. Collins, Richard M. (Bechtel Corp., San Francisco). Trans. Amer. Nucl. Soc., 12: 801-2 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5777 NUCLEAR MANPOWER FOR THE UTILITIES. Rossin, A. David (Argonne National Lab., Ill.); Voigt, Keith L. Trans. Amer. Nucl. Soc., 12: 801(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5778 MANPOWER AVAILABILITY: THE MANUFACTURER'S RESPONSIBILITY. Dempsey, Robert H. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 802 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5779 GLOVE BOX FACILITY FOR PYROCHEMICAL RESEARCH AND DEVELOPMENT WORK WITH ^{238}Pu. Fischer, Jack (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 848(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5780 MANNING FOR THE NUCLEAR AGE: ONE UTILITY'S VIEWPOINT. Wandke, Norman E. (Commonwealth Edison Co., Chicago). Trans. Amer. Nucl. Soc., 12: 803(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5781 MOBILE GEOCHEMICAL LABORATORY SYSTEM USING REMOTE DATA ANALYSIS AND ACQUISITION. Trombka, J. I. (Goddard Space Flight Center, Greenbelt, Md.); Schmadebeck, R. L.; Senftle, Frank. Trans. Amer. Nucl. Soc., 12: 472-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5782 IRRADIATION DEVICE. Tamura, Kazo (to Kimura Entetsu Kagaku Kikai Co.). Japanese Patent 1969-18586. 11 Aug 1969. Filed 18 May 1966.

A device is proposed whereby organisms, metals, chemicals, etc., can be irradiated safely and reliably, for a given period of time, or intermittently. A rotating box, operable from outside, is used. Inside the box, two bevel gears opposed to each other are fixed in a direction perpendicular to the axis, and two other bevel gears in the axis direction engage with the two gears. One of the bevel gears in the axis direction is connected to a rotating disc with a notch on the circumference, which opens a lid. The other gear of this pair is connected to a shaft with a cut on the surface, which lifts a radiation source. When the circumference other than the notched part is in the cut of the shaft, the disc is rotated, and when the notched part is at the position of the shaft, the shaft is moved upward and downward. (NSA of Japan)

5783 CAPSULES FOR SAMPLES TO BE IRRADIATED IN NUCLEAR REACTORS. Oshima, Keichi; Yamazaki, Yasaburo; Hirata, Mitsuho; Ishii, Toshio; Shimozawa, Ryosuke; Sato, Shoichi; Moriyama, Noboru (to Japan Atomic Energy Research Inst.). British Patent 1,171,415. 19 Nov 1969. Priority date 26 Apr 1967, Japan.

The design is given of a capsule for holding samples for irradiation in a nuclear reactor. Thermally conductive fins extend between the inner and outer capsule. The inner capsule is designed with a rupture plate, and pressure and temperature detecting heads are attached to the inner capsule. Attached to the capsule is a wire by which it is moved within a pneumatic system for moving the capsule within the reactor. (J.C.W.)

5784 FACILITY FOR EXTRACORPOREAL IRRADIATION OF BLOOD AT THE NATIONAL HOSPITAL, COPENHAGEN. Andersen, Vagn (National Hospital, Copenhagen); Gram, Niels; Rasmussen, Ingvard; Weeke, Eva. Forsk. Udvikling-Uddannelse (Copenhagen); 78: 198-202(1969). (In Danish).

Extracorporeal irradiation (ECI) of blood has been used for clinical research and for treatment purposes at the National Hospital, Copenhagen, since 1967. The prototype irradiation facility, based upon a ^{60}Co source with a nominal strength of 1000 Ci, was designed by the Danish Atomic Energy Commission Research Establishment, Risoe. A description is given of the design and construction of the facility. The ECI technique has been used for treatment of patients with chronic lymphocyte leukaemia. Also patients in terminal anaemia have been treated by ECI as pre-transplantation immuno-suppressive therapy. A presentation of clinical experience is given. To meet the increased requirements a second irradiation facility is now under development, based upon a ^{137}Cs source and designed as a mobile unit. (auth) (Denmark)

Heat Transfer and Fluid Flow

Refer also to abstracts 7058, 7104, 7163, and 7258.

5785 (AD-691213) HEAT TRANSFER FROM RADIOISOTOPIC POWER SOURCES IN POROUS MEDIA. Schrock, V. E.; Fernandez, T.; Garribba, S.; Narra, S. (California Univ., Berkeley. Coll. of Engineering). June 1968. Contract N00228-68-C-0554. 97p. (NE-68-1). CFSTI.

Heat transfer from radioisotopic full fuel capsules was studied experimentally and analytically for the situation in which the capsule is buried in a porous earth material saturated with water as would occur when such a capsule becomes accidentally buried in the ocean floor. Experimental conditions have been extended beyond the range reported previously by testing devices with different length-diameter ratios and using a greater range of burial depths. The previously reported correlation for natural convection has been modified to include the greater range of parameters and the effect of length to diameter ratio. Theoretical treatment of the free convection case has been studied to establish the validity of the basic equations governing the system. Data have been obtained and analyzed for the nucleate boiling regime. Additional data have been obtained for the dryout condition and on the formation of crusts on the capsule. (auth) (USGRDR)

5786 (CISE-R-119) ONESTO: A DIGITAL CODE TO CALCULATE STEADY STATE HYDRODYNAMIC PARAMETERS IN A BOILING CHANNEL. Topical Report No. 12. Brusa, L.; Muscettola, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). May 1964. Contract 005-63-7-NTRI. 44p. Dep. CFSTI (U. S. Sales Only).

ONESTO, a code for the Olivetti ELEA 6001 digital computer, evaluates the steady state hydrodynamic conditions for vertical upflow of a steam-water mixture in a channel when inlet conditions are given. The code calculates pressure drop, steam quality, steam volume fraction, and mixture density along the channel, both for adiabatic flow and with power addition. The basic equations used to characterize the hydrodynamic conditions of the mixture are derived from the laws of conservation of mass, momentum, and energy. The channel considered is a circular pipe and the rod is a long cylinder or cone. (J.C.W.)

5787 (GA-9263) TAC3D: A GENERAL PURPOSE THREE-DIMENSIONAL HEAT TRANSFER COMPUTER CODE. User's Manual. Petersen, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). Sep 1969. Contract AT(04-3)-167. 81p. Dep. CFSTI.

TAC3D is a code for calculating steady-state and transient temperatures in three-dimensional problems by the finite difference method. It is written entirely in FORTRAN V. The configuration of the body to be analyzed is described in the rectangular or cylindrical coordinate system by orthogonal planes of constant coordinate called grid planes. The grid planes specify an array of nodal elements. Nodal points are defined as lying midway between the bounding grid planes of these elements. A finite difference equation is formulated for each nodal point in terms of its capacitance, heat generation and heat flow paths to neighboring nodal points. A system of these equations is solved by an implicit method which is the most efficient known at this time. Some advantages of the code are: the geometrical input is simple; the input of thermal parameters is by FORTRAN V arithmetic statement functions. Many of the calculation variables (time, local temperature, local position, etc.) are available for use in these functions; internal and external flowing coolants may be used; there may be internal and external thermal radiation; and there is a wide selection of optional output. The principal limitations of the code are: the grid plane system must be orthogonal in the rectangular or cylindrical coordinate system; all radiation is treated one-dimensionally; and there are no provisions for thermal expansion or change of phase (such special heat transfer situations could be included by extensions of the existing programming). TAC3D has been assigned operational status. The machine requirement is a 65K Univac 1108, or equivalent. In addition to input-output, a maximum of four and a minimum of no tapes are required depending upon the code options being used. (auth)

5788 (SCL-RR-69-131) WALL TO FLUID HEAT TRANSFER IN TURBULENT TUBE FLOW FOR A DISTURBANCE IN INLET TEMPERATURE. Landram, Charles S. (Sandia Labs., Livermore, Calif.). Dec 1969. Contract AT(29-1)-789. 44p. Dep. CFSTI.

Transient heat transfer from a semi-infinite tube wall to a fluid flowing steadily through the tube is obtained for any prescribed temporal inlet fluid temperature. Graphs, based on several non-dimensional parameters, are presented to facilitate calculations when the actual fluid inlet temperature is represented by a series of steps in time. (auth)

5789 (UCRL-14754(Rev.2)) TRUMP: A COMPUTER PROGRAM FOR TRANSIENT AND STEADY-STATE TEMPERATURE DISTRIBUTIONS IN MULTIDIMENSIONAL SYSTEMS. Edwards, Arthur L. (California Univ., Livermore. Lawrence Radiation Lab.). 1 Jul 1969. 263p. Dep. CFSTI.

TRUMP solves a general nonlinear parabolic partial differential equation describing flow in various kinds of potential fields, such as fields of temperature, pressure, and electricity and magnetism; simultaneously, it will solve two additional equations representing, in thermal problems, heat production by decomposition of two reactants having rate constants with a general Arrhenius temperature dependence. Steady-state and transient flow in one, two, or three dimensions are considered in geometrical configurations having simple or complex shapes and structures. Problem parameters may vary with spatial positions, time, or primary dependent variables—temperature, pressure, or field strength. Initial conditions may vary with spatial position; and among the criteria that may be specified for ending a problem are upper and lower limits on the size of the primary dependent variable, upper limits on the problem time or on the number of time steps or on the computer time, and attainment of steady state. Solutions may be obtained by use of explicit- or implicit-difference equations, or by an optimized combination of both. TRUMP is primarily written in FORTRAN IV, is subdivided into modular subroutines, and is readily adaptable to most computer systems. The amount of computer time required varies with the user's equipment and needs, but averages from 0.3 to 2 msec per time step for each nodal point and connection between nodal points. (auth)

5790 PRESSURE GRADIENT IN FLASHING SODIUM FLOW. Fauske, H. K.; Grolmes, M. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 908-9(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5791 HEAT TRANSFER TO LIQUID METALS FLOWING THROUGH CLOSELY SPACED ROD BUNDLES. Dwyer, O. E. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 804(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5792 MECHANISM FOR TURBULENT MIXING BETWEEN ROD BUNDLE SUBCHANNELS. Rowe, D. S. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 805(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5793 EFFECT OF SUBCOOLING ON THE ONSET OF TRANSITION BOILING. Witte, L. C.; Stevens, J. W.; Henningson, P. J. (Univ. of Houston, Tex.). Trans. Amer. Nucl. Soc., 12: 806(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5794 FLAT-PLATE HEAT TRANSFER AUGMENTATION. Thompson, T. J.; Spurgeon, D. R. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 808-9(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5795 POST-DRY-OUT HEAT TRANSFER WITH STEAM/WATER MIXTURES. Brevi, R.; Cumo, M.; Palmieri, A.; Pitimada, D. (CNEN, Casaccia, Italy). Trans. Amer. Nucl. Soc., 12: 809-10(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5796 POST-BURNOUT HEAT TRANSFER UP TO THE CRITICAL PRESSURE. Cumo, M.; Farello, G. E.; Ferrari, G. (CNEN, Casaccia, Italy). Trans. Amer. Nucl. Soc., 12: 810-1 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5797 THERMAL RADIATION TRANSPORT IN PARTICLE-SEEDED GASES. Williams, J. R. (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc., 12: 811-12(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5798 DYNAMIC MODEL OF SPTF MAIN FLOW LOOP. Balekjian, G.; Koppany, C. R.; Marhauer, H. H. Trans. Amer. Nucl. Soc., 12: 829-30(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5799 ACOUSTIC TECHNIQUES FOR FLOW REGIME AND GAS DETECTION. Grolmes, M. A.; Fauske, H. K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 832-3(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5800 PROPAGATION OF ACOUSTIC WAVES IN TWO-PHASE, TWO-COMPONENT MEDIA. Mecredy, R. C.; Hamilton, L. J. (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 12: 833(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5801 INITIAL- AND BOUNDARY-VALUE FLOW SOLUTIONS DURING BOILING IN TWO INTERCONNECTED PARALLEL CHANNELS. Rowe, D. S. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 834-5(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5802 COMPUTATION EFFICIENCY IN SOLVING FLOW NETWORK PROBLEMS. Malek, G. J. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 835-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5803 PRESSURE DROP MEASUREMENTS IN TWO-PHASE FLOW. Grillo, P.; Marinelli, V. (CNEN, Casaccia, Italy). Trans. Amer. Nucl. Soc., 12: 836-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5804 PRESSURE DROP MEASUREMENTS IN ISOTHERMAL SINGLE-PHASE FLOW. Grillo, P.; Marinelli, V. (CNEN, Casaccia, Italy). Trans. Amer. Nucl. Soc., 12: 838-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5805 FLOW-VELOCITY-DEPENDENCE OF DAMPING IN PARALLEL-FLOW-INDUCED VIBRATION. Wambsganss, M. W. Jr.; Zaleski, P. L. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 839-40(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5806 EFFECTS OF XENON ON FUEL-TO-CLADDING GAP CONDUCTIVITY. Horn, G. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 607-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5807 AN INSTALLATION INCLUDING A ONCE-THROUGH STEAM BOILER. (to Siemens AG). British Patent 1,171,260. 19 Nov 1969. Priority date 9 Dec. 1967, Germany.
The design is given of an installation including a once-through steam boiler having a section of the boiler tubing in which the working medium flows continuously upward and in which there are no headers or other mixing vessels. An indicator valve signals the degree of fullness of water and when a predetermined fullness has been reached. The installation may include a nuclear reactor cooled by a gaseous heat carrier which flows downward adjacent to the tubing of the steam boiler. (J.C.W.)

Isotope Technology

Refer also to abstracts 5746, 5748, 5781, 5785, 5835, 5836, 5838, 5839, 5957, 6033, 6472, 6583, and 6600.

5808 (MLM-1680(tr)) SEPARATION TUBE. XVII. PREPARATION OF PURE RARE ISOTOPES OF ARGON, ^{36}Ar AND ^{38}Ar. Clusius, K.; Schumacher, E.; Huerzeler, H.; Hostettler, M. U. Translated by S. J. Fershee (Mound Lab., Miamisburg, Ohio), from Z. Naturforsch., 11A: 709-15(1956). 12p. Dep. CFSTI.
A concentrate containing up to 14.5% ^{38}Ar was isolated from 1000 liters of industrial argon in three steps; only 0.063% of this rarest stable isotope occurs in natural argon. The concentration distribution in the ternary system $^{36}Ar/^{38}Ar/^{40}Ar$ was measured and found to agree with the separation column theory. A further separation was made by adding a DCl/HCl misbure almost quantitatively. With that, ^{36}Ar was obtained at a purity of 99.9%, corresponding to a total separation factor of 296,000. Argon-38 was obtained at a purity of 99.6%, corresponding to a total separation factor of 790,000. The analysis of the concentration distribution of the three isotopes of argon in the auxiliary gas mixture $D^{37}Cl/D^{35}Cl/H^{37}Cl/H^{35}Cl$ led to the following statements: The distribution function of the argon isotope is not changed by the auxiliary gas; this applies, therefore, to the theory of the independent separation, which was stated earlier. With the auxiliary gas, however, the characteristic column length for the argon isotope is increased about 45%. With the operating conditions used the thermal diffusion of the HCl toward argon disappears when the HCl is about 1.1 mass units lighter; this effect is caused by the different effective cross sections and the various discrepancies in actual behavior of the two gases. An auxiliary gas of $D^{35}Cl$ with a supplement of $D^{37}Cl$ is especially favorable for the $^{38}Ar/^{40}Ar$ separation, as is an auxiliary gas of $H^{35}Cl$ with a supplement of $D^{35}Cl$ for the $^{36}Ar/^{38}Ar$ separation. (auth)

5809 A SOURCE OF MONOENERGETIC ELECTRONS OF 0.5 TO 3.5 MeV FOR SCINTILLATION COUNTER STUDIES. Jean-Marie, B. (Ecole Normale Superieure, Orsay, France). Nucl. Instrum. Methods; 75: 287-92(1969).
This article describes an apparatus producing monoenergetic electrons. This beam having an energy distribution width of only 3% may be used to study light output and attenuation of scintillation counters and for tests of thin-plate spark chambers. The maximum obtainable energy depends on the nature of the source employed. With 600 μc of ^{90}Sr, 500 counts/sec are produced at 2 MeV. Results are given for various scintillators and for light attenuation measurements under particular conditions. (auth)

5810 CONTINUOUS CIRCULATION OF LIGHT AUXILIARY GASES IN THERMAL DIFFUSION PLANTS. Meinrenken, J. (Univ., Goettingen, Ger.). Kernenergie; 12: 297-302(Sept 1969). (In German).
With respect to their different applicability in the Clusius-Dickel thermal diffusion column, auxiliary gases may be classified as quasi-isotopic, chemical, and extractive gases. In the following, experimental techniques for the dosage of large or small amounts of the gases added are described for the first time, adapted to the conditions occurring with this technique. The experiments carried out with auxiliary gases so far are compiled, and experiments and reflections for an extractive thermal diffusion on the basis of the new technique substantiated here are given. (auth)

5811 IRRADIATED RADIUM-BERYLLIUM NEUTRON SOURCE BUILDUP. Kitchen, S. W.; Sherman, D. C. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 12: 511-12(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5812 DESIGN AND FABRICATION OF THE APOLLO LUNAR RADIOISOTOPIC HEATER (ALRH). Kelly, D. P. (Mound Lab., Miamisburg, Ohio); Avona, V. L.; Shivers, R. W. Trans. Amer. Nucl. Soc., 12: 476(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5813 HELIUM RELEASE IN $^{238}PuO_2$. Angelini, P. (Oak Ridge National Lab., Tenn.); McHenry, R. E.; Scott, J. L.; Ernst, W. S. Jr.; Prados, J. W. Trans. Amer. Nucl. Soc., 12: 477-8 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5814 SPECTRAL ANALYSIS OF GAMMA RADIATION FROM A SNAP-15A SOURCE. Reier, M.; Campbell, R. W. (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc., 12: 478-9 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5815 THERMAL CONDUCTIVITY OF $^{244}Cm_2O_3$ HEAT SOURCE MATERIAL. Ketchen, E. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 479(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5816 THE AEROKERN RTG. Ruehle, W. (Aerojet-General Corp., San Ramon, Calif.). Trans. Amer. Nucl. Soc., 12: 479-80(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5817 BETAVOLTAIC NUCLEAR ELECTRIC POWER SOURCES. Olsen, L. C.; Seeman, S. E.; Griffin, B. I. (McDonnell Douglas Corp., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 481-2(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5818 CALIFORNIUM PRODUCTION AND USES. Crandall, J. L. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 12: 489(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5819 FUTURE SPACE APPLICATIONS FOR TRANSURANIUM ISOTOPES. Leefer, Bernard I. (Office of Advanced Research and Tech., Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 489-90(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5820 OPTIMIZATION OF ^{237}Np IRRADIATION CONDITIONS FOR ^{238}Pu PRODUCTION. Driggers, F. E. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 12: 490-1(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5821 ^{252}Cf AS A NEUTRON SOURCE FOR MARINE EXPLORATION. Wiggins, P. F. (Naval Academy, Annapolis, Md.); Senftle, F. E.; Duffey, Dick. Trans. Amer. Nucl. Soc., 12: 492 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5822 LITHIUM MICROPROBE TECHNIQUE FOR MEASURING THE CONCENTRATION PROFILE OF HYDROGEN AT SURFACES. Padawer, Gerald M.; Schneid, Edward J. (Grumman Aerospace Corp., Bethpage, N. Y.). Trans. Amer. Nucl. Soc., 12: 493-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5823 LOW-COST HEAVY WATER PRODUCTION BY WATER DISTILLATION. Bolme, D. W.; Young, J. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 496-7 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5824 SAFETY REVIEW AND FUTURE CONSIDERATIONS FOR SPACE RADIOISOTOPE POWER SYSTEMS. Dobry, Thaddeus J. Jr. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 419(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5825 SAFETY REQUIREMENTS FOR ISOTOPE SPACE POWER SYSTEMS. Anderson, D. C. (Isotopes, Inc., Timonium, Md.); Ruwe, D. M. Trans. Amer. Nucl. Soc., 12: 419-20(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5826 AEROSPACE SAFETY IN LAUNCH OPERATIONS AT CAPE KENNEDY. Spencer, Neil C. (Pam Am World Airways, Patrick AFB, Fla.). Trans. Amer. Nucl. Soc., 12: 420-1(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5827 THE MINIGENERATOR: AN INNOVATION FOR TEACHING NUCLEAR PRINCIPLES AND APPLICATIONS. Kramer, H. H.; Arino, H.; Gemmill, W. J. (Union Carbide Corp., Tuxedo, N. Y.). Trans. Amer. Nucl. Soc., 12: 431(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5828 PROFILING SNOW GAGE AND ITS UTILITY IN WATER SUPPLY FORECASTING. Smith, James L.; Halverson, Howard G.; Jones, Ronald (Dept. of Agriculture, Berkeley, Calif.). Trans. Amer. Nucl. Soc., 12: 500-1(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5829 REENTRY PROTECTION OF RADIOISOTOPE CAPSULES BY THERMAL SWITCH COMPOSITES. Princiotta, Frank T.; Barr, Harold N. (Hittman Associates, Inc., Columbia, Md.). Trans. Amer. Nucl. Soc., 12: 420(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Materials Testing

Refer also to abstracts 5775, 5847, 6184, and 6199.

5830 ACOUSTIC EMISSION: STRESS WAVE DETECTION AS A TOOL FOR NONDESTRUCTIVE TESTING AND MATERIAL EVALUATION. Engle, Robert B.; Dunegan, Harold L. (Univ. of California, Livermore). Int. J. Non-Destruct. Test.; 1: 109-25(Jun 1969).

Methods for nondestructive testing and material evaluation using acoustic-emission signals are reported. Experimental results show that emission from flawed specimens is characteristically different from emission from flaw-free specimens. Experiment also shows that acoustic emission from flawed specimens is normalized by the stress intensity factor that is basic to the study of brittle fracture. These results suggest applications to non-destructive testing and material evaluation that are being investigated at the Lawrence Radiation Laboratory, Livermore. Applications discussed are a proposed acceptance test and fatigue crack extension monitoring, in the area of NDT, and determination of a critical stress intensity factor for stress corrosion cracking, in the area of material evaluation. Data from tensile tests of 7075-T6 aluminum suggest a correlation between the acoustic-emission rate and an expression describing mobile dislocation density as a function of plastic strain. Further search is intended for correlations between acoustic-emission behavior and dynamic dislocation parameters. (auth)

5831 AUTORADIOGRAPHY OF IRRADIATED NUCLEAR CERAMIC FUELS. Gruber, W. J. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 842-3(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5832 PRESENT STATE OF METALLOGRAPHIC TECHNIQUES IN THE HOT CELLS OF THE CEA. Vignesoult, N. (CEN de Saclay, Gif-sur-Yvette, France). Trans. Amer. Nucl. Soc., 12: 845-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5833 USES OF A TRIGA NEUTROVISION SYSTEM INCLUDING EXAMINATION OF RADIOACTIVE MATERIAL. Whittemore, W. L.; Schnurer, G. T.; McMain, A. T. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 846-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5834 EXPLOSIVE TECHNIQUE FOR PRESSURE PULSE TESTING OF REACTOR COMPONENTS. Boers, Burdette L. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 828(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5835 APPLICATIONS OF NEUTRON RADIOGRAPHY USING A RADIOACTIVE NEUTRON SOURCE. Albertson, Darryl G.; Rathke, D. P. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 12: 462(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5836 NEUTRON RADIOGRAPHY USING A SMALL SUB-CRITICAL ASSEMBLY. Bouchey, G. D.; Gage, S. J. (Univ. of Texas, Austin). Trans. Amer. Nucl. Soc., 12: 462-3(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5837 AN ELECTRON LINAC NEUTRON SOURCE FOR NEUTRON RADIOGRAPHY. Whittemore, W. L. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 463-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5838 NEUTRON RADIOGRAPHY WITH ^{252}Cf. Cason, J. L.; Shaw, C. B. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 464-5(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5839 THERMAL-NEUTRON RADIOGRAPHY WITH ^{252}Cf AND OTHER SMALL SOURCES. Barton, J. P.; Klozar, M. F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 465-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5840 RECIPROCITY FAILURE OBSERVATIONS IN RADIOGRAPHY WITH LOW-INTENSITY NEUTRON BEAMS. Hawkesworth, M. R. (Univ. of Birmingham, Eng.). Trans. Amer. Nucl. Soc., 12: 466-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5841 TELEVISION SYSTEM FOR NEUTRON RADIOGRAPHY USING SMALL SOURCES. Brown, Robert L. (Marshall Space Flight Center, Huntsville, Ala.). Trans. Amer. Nucl. Soc., 12: 467(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5842 NEUTRON RADIOGRAPHY EXPERIENCE WITH AN ISOTOPIC SOURCE IN THE EBR-II FUEL CYCLE FACILITY. Cutforth, D. C. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 467-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5843 DEMONSTRATION OF THE NEED FOR A HIGH FLUX NEUTRON BEAM IN NEUTRON RADIOGRAPHY DEVELOPMENT. Miller, L. G. (Idaho Nuclear Corp., Idaho Falls); McNeece, J. P. Trans. Amer. Nucl. Soc., 12: 468-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5844 THERMAL-NEUTRON RADIOGRAPHY WITH SMALL ACCELERATORS. Iddings, F. A. (Louisiana State Univ., Baton Rouge); Bostrum, N. A. Trans. Amer. Nucl. Soc., 12: 469-70 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5845 NONDESTRUCTIVE EVALUATION OF CLADDING COLD WORK AND GRAIN SIZE. Becker, F. L.; Trantow, R. L. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 540(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5846 ANALYSIS OF FUEL ELEMENT SECTIONS BY TWO-DIMENSIONAL GAMMA SCANNING. Barnes, Barry K.; Sanders, W. Mort; Holm, Dale M. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 542-3(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Protective Structures

5847 (ORNL-TM-2755) MOTION OF ELASTO-PLASTIC MEMBRANES UNDER SHOCK LOADING. Dresner, Lawrence (Oak Ridge National Lab., Tenn.). 30 Oct 1969. Contract W-7405-eng-26. 39p. Dep. CFSTI.

The motion of an infinitely long strip of foil with clamped edges was calculated under the following circumstances: pressure wave incident either head on or side on, and membrane stress either constant or proportional to strain. The constant-stress case was solved completely by the method of characteristics. The membrane profile and the maximum strain were known as a function of the incident pressure, membrane thickness, membrane width, and membrane stress. A similarity solution is known for the membrane in which stress is proportional to strain for head-on incidence. It describes the early stages of membrane motion. It gives an acceptable approximation to the maximum strain as a function of incident pressure, membrane thickness, membrane width, and membrane modulus. Numerical solutions of the equations of membrane motion are described. (auth)

Radioactive Material Handling

Refer also to abstracts 5749, 5779, and 5954.

5848 (BNWL-1215) SURVEY OF TRANSPORT METHODS FOR SHORT TERM IRRADIATION FACILITIES. Mahaffey, M. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 33p. Dep. CFSTI.

Methods and systems for achieving short term irradiations in test reactors are reported. Systems discussed include pneumatic facilities for fast operation, quick handling, and low cost; hydraulic rabbits for accommodating higher heat generation rates, or higher induced activities; and trail cables for accommodating larger, heavier test assemblies while maintaining instrumentation and monitoring. Other hybrid facilities are also described. Probable modifications and problem areas which would be encountered in adapting the above principles to be used in the Fast Flux Test Facility are also discussed. (auth)

5849 (RT/PROT-(69)4) STORAGE SYSTEMS OF HIGH-ACTIVITY LIQUID WASTE: CRITERIA OF DESIGN WITH REGARD TO SAFETY. Pujia, V.; Sennis, C.; Simonetta, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 37p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The storage systems for high activity liquid waste of the type used in Italian plants are described. An analysis of the characteristic risks of these systems was performed. These risks include tank corrosion, boiling of wastes, hydrogen-air mixture detonation, criticality excursions, and earthquakes. (auth)

5850 DETECTOR DEVICE FOR VERIFYING THE HANDLING OF NUCLEAR FUEL. Pinault, Jacques; Lallet, Jean-Paul (to Groupement Atomique Alsacienne Atlantique). British Patent 1,172,708. 3 Dec 1969. Priority date 4 Feb 1966, France.

The design of a detector device is given for use with a grab, for ascertaining the presence of nuclear fuel in a fuel element when the element is being handled by the grab. The device includes a body portion including a cylindrical sleeve of electrically insulating non-magnetic material around which is wound a coil and which is within a displaceable magnetic core. The mechanical construction includes springs and the presence of the fuel rod in its jacket is monitored by a system controlled by changes in inductance. (J.C.W.)

5851 NUCLEAR WASTE PROCESSING PLANT FOR RUMANIA. Holmes, R. E. (Atomic Power Constructions Ltd., London); Jerkins, E. Nucl. Energy, 151-9(Sept.-Oct. 1969).

A description is given of the facility to be built at Bucharest for decontamination and reprocessing of waste from the reactors and laboratories at the Institute of Physics. A schematic layout of the building and flow diagrams for both the active liquid effluent treatment and the waste processing plant are included. Approximate treatment costs are given. (UK)

5852 APPLICATION OF SYSTEMS ANALYSIS TECHNIQUES TO REMOTE SYSTEMS. Harbison, S. G.; Field, R. E.; Graham, D. W. (Aerojet-General Corp., San Ramon, Calif.). Trans. Amer. Nucl. Soc., 12: 848-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5853 ALPHA-GAMMA CELL OF THE JAPAN ATOMIC RESEARCH INSTITUTE. Yoshida, Hiroo (Japan Atomic Energy Research Inst., Tokai); Matsushima, Hideo; Abe, Kyoichi; Seki, Sadao; Tachi, Hirokatsu; Ebihara, Hikoe. Trans. Amer. Nucl. Soc., 12: 849(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5854 DESCRIPTION AND FIRST OPERATIONAL EXPERIENCE OF THE HZ-HOT LABORATORY OF THE KFA JUELICH. Witte, Hartmut O.; Mueller, Hartwig (Kernforschungsanlage, Juelich, Ger.). Trans. Amer. Nucl. Soc., 12: 849-50(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5855 RENOVATING AND EQUIPPING THE LRL BETA–GAMMA HOT CELL FACILITY. Albrecht, E. C.; Johnson, J. M.; Stearns, E. H. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 12: 850(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5856 PADIRAC SYSTEM OF SHIELDED AND CONTAINED CASKS FOR SOLID WASTES OR HIGHLY ACTIVE EQUIPMENT. Vertut, J. (CEN, Fontenay-aux-Roses, France); Lefort, G.; Brisac, Michel; Cazalis, Jean-Pierre. Trans. Amer. Nucl. Soc., 12: 856-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5857 REMOTE REENCAPSULATION OF IRRADIATED MIXED-OXIDE FUEL PINS IN NaK. Irvine, R. M. (General Electric Co., Pleasanton, Calif.); Stimmell, G. L.; Perry, K. J. Trans. Amer. Nucl. Soc., 12: 857-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5858 DESIGN OF THE HOT FUEL EXAMINATION FACILITY ARGON SYSTEM. Landow, E. W.; Hirsch, P. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 860 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5859 NEW PLUTONIUM BUTTON STORAGE ARRANGEMENT. Ridgway, K. R. (Atlantic Richfield Hanford Co., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 893-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5860 AIRBORNE RELEASE OF PLUTONIUM DURING OVERHEATING INCIDENTS. Mishima, J.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 445-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5861 MODEL FOR ANALYZING IRRADIATED FUEL ROD BEHAVIOR DURING THERMAL TRANSIENTS IN SHIPPING ACCIDENTS. Decher, U.; Bleiberg, M. L.; Ruzbacki, J. R. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 12: 447-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5862 OPERATING EXPERIENCE IN A FACILITY UTILIZING SOLUBLE NEUTRON ABSORBERS FOR STORAGE OF FISSILE SOLUTION. Parrott, J. R.; Nichols, J. P.; Nicol, R. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 450(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5863 DIFFUSION OF RADIOISOTOPES THROUGH WASTE SOLIDS. Godbee, H. W.; Fitzgerald, C. L.; Blomeke, J. O.; Blanco, R. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 450-1(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5864 DISPOSAL OF SOLIDIFIED POWER REACTOR WASTES IN SALT MINES. Bradshaw, R. L.; McClain, W. C.; Empson, F. M. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 452(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5865 CESIUM COLD TRAPPING IN A FORCED-CONVECTION Na SYSTEM. Cooper, M. H.; Taylor, G. R. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 611-12(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5866 HOT CELL EQUIPMENT FOR GAS SAMPLING BY LASER PUNCTURING. Dismuke, S. E.; Chandler, T. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 855 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5867 TITANIUM GETTERING SYSTEM FOR PURIFICATION OF GLOVE BOX ATMOSPHERES. Kyle, M. L.; Pierce, R. D.; Tobias, K. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 859(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5868 GASTIGHT SHIELDING WINDOW DESIGN FOR THE HOT FUEL EXAMINATION FACILITY. Eckels, T. W.; Mingesz, D. P. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 859-60(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Vacuum Engineering

Refer also to abstracts 5951 and 6276.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 5809, 5934, 5957, 6450, and 7019.

5869 (AD–692890) X-RAY DETECTION IN SEMICONDUCTORS AND SCINTILLATORS. Final Report. Aitken, Donald W. (Stanford Univ., Calif. High-Energy Physics Lab.). 1 Jan 1969. Contract AF49(638)-1499. 10p. (AFOSR–69-1867-TR). CFSTI.

A program to investigate alkali-halide scintillators and silicon and germanium radiation detectors with x rays and charged particles to determine intrinsic physical properties while also leading to new practical applications of these devices in the low energy region is described. The work performed and the new directions and applications that resulted from the work are described. (USGRDR)

5870 (BARC/HP/TM–15) SHADOW SHIELD WHOLE BODY COUNTER. Habib, Anwar; Katoch, D. S. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 19p. Dep. CFSTI (U. S. Sales Only).

A whole body counter using the shadow shield has been fabricated at Trombay with total shield weighing only two tons. The detector is a 4" dia × 3" thick NaI(Tl) crystal. This facility is routinely used to monitor the occupational workers for body burden due to gamma emitting radioisotopes to ensure that the contamination levels remain well below the limits recommended by ICRP. This whole body counter has been in operation at the Plutonium Plant, Trombay. The main advantages of such a facility as compared with conventional steel room whole body counters are its simplicity in design and much reduced weight of the shielding material without sacrificing sensitivity by any appreciable extent. A few thousandths part of the maximum permissible burden in total body for various isotopes could be detected with an error of less than 20% for a counting time of one hour. Over two hundred subjects have been measured so far, for various fission products, viz., ^{137}Cs, $^{95}Zr-^{95}Nb$, and ^{103}Ru. Results of measurement of typical cases from Plutonium Plant and CIRUS are given. (auth)

5871 (EUR–4269) PROCEEDINGS OF THE MEETING ON SPECIAL TECHNIQUES AND MATERIALS FOR SEMICONDUCTOR DETECTORS, ISPRA, ITALY, OCTOBER 1–2, 1968. Cappellani, F.; Restelli, G. (European Atomic Energy Community, Brussels (Belgium). Center for Information and Documentation). June 1969. 296p. (CONF-681049). $6.00.

Separate abstracts are prepared for 18 of the 19 papers presented. One paper was abstracted previously in NSA as 23: 32557. (J.C.W.)

For abstracts of individual papers see: 5872–5888 and 5916.

5872 (EUR–4269, pp 13-24) LIFETIME MEASUREMENTS IN LITHIUM DRIFTED GERMANIUM P-I-N DIODES. Baldinger, E.; Buschor, F. (Basel Univ. (Switzerland). Institut fuer Angewandte Physik).

The lifetime of carriers injected into the intrinsic zone of lithium-drifted germanium p–i–n diodes was studied using the method developed by Tederhandler and Giacoletto (Proc. Instr. Radio Engrs. 43, 477(1955)). (B.G.D.)

5873 (EUR–4269, pp 25-30) THE EFFECT OF CLUSTERS OF RECOMBINATION CENTRES ON LIFETIME MEASUREMENT. Gibbons, P. E. (Atomic Energy Research Establishment, Harwell (England)).

Previously the hypothesis was put forward that certain trapping levels may be clustered within the germanium crystal. From the detector measurements alone it is not possible to distinguish whether these levels were truly trapping or recombination levels. To avoid this difficulty, it is suggested that since there is evidence of agglomeration of deep levels within the germanium crystal, such a mechanism of cluster formation could apply also to those impurities which form recombination centers. The effect of such clusters on the results of photo-conductive lifetime measurement is considered. (B.G.D.)

5874 (EUR–4269, pp 31-6) CHARGE COLLECTION IN GERMANIUM DETECTORS. Gibbons, P. E. (Atomic Energy Research Establishment, Harwell (England)).

The spectral response of germanium detectors of 0.662 MeV gamma rays was measured and compared with the theoretical response given by Monte Carlo calculations. The photo-peak was taken, in the experimental case, as consisting of all events recorded with energy greater than 652 keV. This was done so that comparison could be made with detectors which showed slight trapping losses leading to a trailing edge on the low energy side of the photopeak, i.e., events showing a trapping loss not greater than 1.7% were included in the photopeak count. The ratio of this to the total events in the Compton distribution is listed and a comparison is made with the results of Monte Carlo calculations based on a program devised by Hopper and Owen at A.E.R.E. The correspondence between theory and experimental values of the best detector listed gives confidence in the accuracy of the calculation. An attempt is made to account for the apparent loss of photopeak events in some detectors. (W.H.K.)

5875 (EUR–4269, pp 37-54) A STUDY OF TRAPPING CENTRES IN Ge(Li) DETECTORS. Schell, K. J.; Nienhuis, K. (Philips Gloeilampenfabrieken N. V., Eindhoven (Netherlands). Forschungslaboratorium).

A study has been made on the influence of trapping centers in Ge(Li) detectors. The relation between the depth of the trapping center and the resolution of the detector has been investigated. Only a small range of energy levels of the trapping centers is responsible for trapping effects in the detector. One of the few impurities that fulfills all the requirements is silver. This assumption is strongly supported by experiments. (auth)

5876 (EUR–4269, pp 55-64) PRELIMINARY RESULTS ON THE DETERMINATION OF IMPURITIES IN GERMANIUM. Cappellani, F.; Restelli, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

Comments and conclusions are presented on attempts to experimentally determine the number and nature of impurities in germanium by spark source mass spectrometry and by neutron activation analysis. The impurities in germanium detectors are important because they act as trapping centers and effectively reduce the resolution of the detectors for gamma spectroscopy. Trapping cross sections and energy levels for various impurities in germanium are tabulated. (W.H.K.)

5877 (EUR–4269, pp 65-80) PROBLEMS IN SELECTING GERMANIUM CRYSTALS FOR LARGE VOLUME Ge(Li) COUNTERS. Lopes da Silva, G.; Henck, R.; Siffert, P. (Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Recherches Nucleaires).

Unsolved problems encountered in fabricating and selecting large-volume germanium detectors for optimum performance for spectroscopy are discussed. These problems include irregular and reduced lithium drift mobility, carrier trapping effects, and capacitance relaxation phenomena. (W.H.K.)

5878 (EUR–4269, pp 81-99) LEAKAGE CURRENT AS A DIAGNOSTIC MEASUREMENT ON GERMANIUM MATERIAL. Ellis, R. (Atomic Weapons Research Establishment, Aldermaston (England)).

In the diagnostics of germanium material for use in lithium-drifted gamma spectrometers one of the useful parameters missing from manufacturer's specifications is the room temperature diode voltage current characteristic for a specified depleted volume. Its implication on the processing of a typical lithium-drifted gamma spectrometer is stated. (auth)

5879 (EUR–4269, pp 103-18) DEFECTS IN Ge(Li) DETECTOR EFFICIENCIES. Walford, G.; Doust, C. E. (Surrey Univ., London (England)).

A study was made of the variation of active volume and full peak efficiency of Ge(Li) detectors. It was found that only high resolution detectors had the expected high efficiencies. An eddy current technique is proposed for investigating the internal variation of the p-i-n contours. (auth)

5880 (EUR–4269, pp 121-31) PRODUCTION OF LARGE VOLUME Ge(Li) DETECTORS. Muggleton, A. H. F. (Nuclear Enterprises Ltd., Edinburgh (Scotland)).

Techniques and problems involved in manufacturing large Ge(Li) detectors on an industrial scale are described. (auth)

5881 (EUR–4269, pp 133-6) EXPERIENCES AND PROBLEMS IN THE INDUSTRIAL PRODUCTION OF Ge(Li) DETECTORS. Paugger, P. (Nucletron, Gesellschaft fuer Nucleonic und Electronic m.b.H., Munich (West Germany)).

The production of surface barrier and lithium-drifted germanium detectors at Nucletron is discussed. The system necessary for spectrometry has been developed and the FET preamplifier has a resolution of 1 to 2 keV for zero input capacitance and a slope of 0.02 keV/pF. (J.C.W.)

5882 (EUR-4269, pp 144-60) SILICON INTERNALLY AMPLIFYING DIODES: SCINTILLATOR, PHOTODIODE, ASSOCIATION. Roubert, F.; Siffert, P. (Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Recherches Nucleaires).

The development, operation, and performance of photodiodes with internal amplification for use as optical readout devices for scintillation detectors are discussed. The design of a thallium-activated cesium iodide scintillation detector with a gallium-diffused silicon photodiode is described, and its performance for alpha spectroscopy is illustrated. (W.H.K.)

5883 (EUR-4269, pp 161-76) CHARACTERISTICS OF ION-IMPLANTED CONTACTS FOR NUCLEAR PARTICLE DETECTORS. PART I. WINDOW THICKNESS OF ION-IMPLANTED SEMICONDUCTOR DETECTORS. Meyer, O. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik).

The thickness of the entrance window of ion-implanted semiconductor counters was experimentally studied by pulse height defect measurements. It was found that the window thickness D strongly depends on the reverse voltage U_A. This dependence may be described by the function $U_A = F(D)^{-\eta}$. The influence of the following parameters on the constants F and η was measured: doping concentration of the base material, energy of the implanted ions, total number of implanted ions, annealing temperature, and crystal orientation. For boron-implanted contacts a formula is given that describes the measured results within 20%. Under certain conditions extremely thick windows up to 10 μm were found. In high resistivity material (100,000 ohm cm) for example thin windows (<0.02 μm) require high reverse voltage (~600 V); whereas in silicon with a resistivity smaller than 10,000 ohm cm, thin windows can easily be obtained even at small detector bias. (auth)

5884 (EUR-4269, pp 177-92) CHARACTERISTICS OF ION-IMPLANTED CONTACTS FOR NUCLEAR PARTICLE DETECTORS. PART II. CONCENTRATION DISTRIBUTION IN ION-IMPLANTED CONTACTS FOR SEMICONDUCTOR DETECTORS. Meyer, O. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik).

An analytical treatment is given which allows the calculation of the depth concentration of electrically active centers in ion-implanted contacts, starting from the measured dependence of the window thickness on reverse voltage. The influence of the following parameters on the depth distribution is studied: dopants, ion energy, ion concentration, doping concentration of the base material, crystal orientation, and annealing temperature. By variation of the doping concentration of the base material it is possible to determine the concentration distribution over six orders of magnitude. The minimum detectable concentration is about 10^{12}/cm^3. The results are related to other observations obtained in measuring concentration profiles by different methods. (auth)

5885 (EUR-4269, pp 193-220) ION IMPLANTED SEMICONDUCTOR DETECTORS. Bader, R.; Herzer, H.; Kalbitzer, S.; Stumpfl, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)).

Nuclear particle detectors have been fabricated by ion implantation techniques that are equal or superior in performance to those made by conventional methods. They were made by implanting boron through one surface of a silicon wafer, and phosphorus through the opposite surface, by accelerating the ions to energies in the 1 to 10 keV region. The fabrication requires implanting the proper amount of dopant ions, annealing the radiation damage, and making contacts to the doped layers. The most important parameters that must be controlled to obtain quality detectors are discussed including pertinent theoretical considerations. The performance and basic properties of these diodes are reported. Excellent resolution is obtained with these detectors, effective window thicknesses of less than 0.2 μm can be produced, and most detectors can be fully depleted and operated with over-voltage. By the application of the ion implantation technique for fabrication of both one dimensional and two dimensional position sensitive detectors, the resistive layer of these detectors can be carefully controlled and optimum performance is obtained. (auth)

5886 (EUR-4269, pp 221-8) LARGE-AREA POSITION-SENSITIVE SEMICONDUCTOR DETECTOR MADE BY ION IMPLANTATION. Laegsgaard, E. (Aarhus Univ. (Denmark). Fysisk Institut).

Ion implantation of position-sensitive detectors has shown potential advantages over evaporation and diffusion techniques, the main one being the precise control of the uniformity and concentration of implanted impurity ions. Also the low heating treatment required and the stability of the device are of importance. Large-area detectors (8×48 mm^2) have been made by this technique, giving a position resolution of less than 0.5% FWHM of the detector length and a linearity better than ±0.5% when the device is cooled to liquid-nitrogen temperature. (auth)

5887 (EUR-4269, pp 251-66) STUDY OF JUNCTIONS DUE TO IMPLANTATIONS OF PHOSPHORUS IONS INTO SILICON. Monfret, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires).

Characteristics of diodes using 20 keV phosphorus ion implantations into silicon are reviewed. Special features of these diodes are presented and correlation with technology is studied. A schematic model of the component is studied; the influence of cleaning and annealing treatments are shown, and optimized fabrication conditions are determined. Comparison to standard diffused diodes is made, and it is estimated that implanted diodes present electrical characteristics quite similar to those of conventional diffused diodes. (auth)

5888 (EUR-4269, pp 267-82) ION IMPLANTED GERMANIUM PARTICLE DETECTORS. Dearnaley, G.; Hardacre, A. G.; Rogers, B. D. (Atomic Energy Research Establishment, Harwell (England)).

Thin-windowed germanium detectors have been prepared by ion implantation with gallium followed by a conventional lithium ion-drift. Such a detector has shown an overall energy resolution of 37 keV (FWHM) for 35 MeV protons. Of this total linewidth, the contribution due to the detection system alone is estimated to be 21 keV. A description is given of a cryostat assembly which allows dE/dx and E particle discrimination by means of a silicon and germanium detector telescope. Other applications of thin-windowed germanium detectors are also considered. (auth)

5889 (IFA-NR-29) FAST TRANSISTORIZED TIME-TO-AMPLITUDE CONVERTER. Hulubei, V.; Omelianenko, M. (Academia R. S. R., Bucharest. Institutul de Fizica Atomica). 1969. 14p. Dep. CFSTI (U. S. Sales Only).

A time-to-amplitude converter in the nanosecond range operating on the start-stop principle for use with a scintillation counter is presented. All the elements involved in the device are discussed individually. The circuit is rather similar to the overlap in principle, but has single-valued pulse height vs time characteristics provided by the hysteresis of a tunnel diode. High switching speeds are obtained with fast diode, tunnel diode, plus u.h.f. transistor combinations, improving the timing performances. (auth)

5890 (UCRL-50485) TRAPPING AND TAILING EFFECTS IN Ge(Li) DETECTORS. Armantrout, Guy Alan (California Univ., Livermore. Lawrence Radiation Lab.). Aug 1969. 102p. Dep. CFSTI.

Studies of performance degradation in Ge(Li) detectors (very high-resolution gamma-ray spectrometers) led to development of models more exact than previous ones to describe detector spectrum degradation as caused by traps and inhomogeneities. Measurements were developed or adapted to study specific aspects of detector performance and to measure pertinent trap parameters; these measurements included infrared absorption properties of the initial germanium, response of the detector to monochromatic infrared light, infrared-transmission television, reverse current versus temperature characteristic of the detector, photoconductive decay time, electrolytic-etching and copper-staining decoration of the crystal, and direct detector performance evaluation. Detectors that have a very large field dependence of resolution on the applied bias showed anomalous behavior traceable to a fast localized lithium precipitation rate, whereas a second class of detectors behaved in the manner predicted by the simple trapping models described by Day and Tramwell. In addition to lithium, the most important impurities that behave as traps are copper, nickel, and iron, and the values of the capture cross sections of these impurities were determined and were found to correspond to neutral traps as a result of the screening of the normally charged traps by the lithium ions. The effectiveness of defects as traps depends on the interaction of lithium with these defects. Lithium is found to exist in two differing passive phases in germanium: 1) the precipitated phase, which introduces many allowed energy levels in the band-gap, acts as a hole trap with an effective capture cross section in the range of 10^{-13} to 10^{-14} cm^2; and 2) the formation of a lithium-defect interaction phase, which depends on the presence of thermal acceptors, results in an electron trap with a discrete level located at $E_c - E_t = 0.22$ eV. The lithium-defect trap is the most important trap that was observed and has a capture cross section on the order of 5×10^{-13} cm^2. (auth)

5891 CURRENT TRENDS IN LIQUID SCINTILLATION DATA PROCESSING. Lumb, B. R. (G. D. Searle and Co., Ltd., Chicago). World Med. Instrum.; 7: 8-11(Mar 1969).

Applications of data processing techniques to calculation and measurement of liquid scintillation samples are outlined and re-

viewed. Typical circuitry of liquid scintillation counters is presented, and the use of small desk top computers coupled to counters to facilitate calculations of multiple radioisotope measurements is described. Development of computer programs and calculation procedures are discussed and evaluated. Specific examples of calculations and procedures, examples of block diagrams of data processing procedures, and related data are discussed. (BBB)

5892 STUDY ON THE IMPROVEMENT OF RADIOACTIVITY RATE MEASURING TECHNIQUES. (RESEARCH REPORT NO. 6). Wang, Chueh-ming (National Taiwan Univ., Taipei). Proc. Nat. Counc. Sci. Develop. Repub. China (Taiwan); No. 2, 115-32 (Oct 1968). (In Chinese).

A mathematical analysis is made of statistical aspects of measurements of radioactivity count rates. A detailed analytical procedure is described to test the adequacy of radioactivity rate (RR) counting per 2-sec period replicated 150 times. Random sampling resulting from RR counts per 2-sec replicated 150 times were shown statistically to be unreliable as indicated by the relatively small values of $\chi^2(\bar{x}_i)$ and $\chi^2(s_i^2)$. For convenience, a definition of the reliability of random samples of RR counts is established as follows: It is supposed that there are k random samples of RR of size n'_i from the k replications of RR counts, n'_i numerically ranging from 20 to 150. From these random samples of size n'_i, the $\chi^2(\bar{x}_i)$'s due to variations among their means ($\bar{x}_i$'s) and the $\chi^2(s_i^2)$ due to variations among their mean squares (s_i^2's) arise and the larger the values of $\chi^2(\bar{x}_i)$ and $\chi^2(s_i^2)$ are, the smaller the reliability becomes; that is, they are inversely proportional. Hence, the reliability of samples can be expressed by the reciprocal of χ_i^2 calculated from them, such as $1/\chi_1^2$ and $1/\chi_j^2$ and $1/\chi_1^2 > 1/\chi_j^2$, if $\chi_1^2 < \chi_j^2$. The relative reliability can then be expressed as the percentage of χ_1^2, χ_j^2 being 100%. Expressions are also developed for testing the significance of the measurements from the chi-square values. (BBB)

5893 NOVEL OXADIAZOLE DERIVATIVES AND THEIR USE AS SCINTILLATION SUBSTANCES. (to Ciba Ltd.). British Patent 1,164,607. Sept. 17, 1969. Priority date Sept. 15, 1965, Switzerland.

The preparation of oxadiazole derivatives for use as scintillation compounds in the scintillation method of counting atomic disintegrations is described. The compounds prepared are: 2-(4-biphenylyl)-5-(p-tert-butylphenyl)-1,3,4-oxadiazole, 2,2′-bis[5-(p-tert-butylphenyl)-1,3,4-oxadiazole], and 2,2′-bis[5-(p-propylphenyl)-1,3,4-oxadiazole]. (D.H.M.)

5894 LIVE TIME CONTROLLED SCANNING RATE FOR A WHOLE BODY COUNTER. Sveum, M. E.; Bramson, P. E. (Battelle Memorial Inst., Richland, Wash.). Rev. Sci. Instrum.; 40: 1616-17(Dec 1969).

Scanning whole body counters tend to sacrifice sensitivity and introduce measurement error through the use of constant drive rate mechanisms which do not readily compensate for changes in electronic deadtime. An electronic drive rate control has been developed at Battelle-Northwest Laboratory which largely eliminates this problem. The control automatically adjusts the relative drive rate to correspond to multichannel analyzer live time and is easily programmed for subject height and count duration. Digital circuitry, utilizing integrated circuits, controls the speed of a heavy duty stepping motor by controlling the motor stepping frequency. A scanning whole body counter utilizing the typical constant drive rate tends to underestimate the body or organ burden of a subject whose deposition caused abnormally high analyzer deadtime. A counter utilizing the live time control will spend proportionally more real scanning time over an area of high deposition, resulting in a desired amount of "scanning live time" for which the counter calibrations apply. (auth)

5895 DEVICE FOR RAPIDLY CHECKING X-RAY BEAM UNIFORMITY. Procter, N. M. (Western General Hospital, Edinburgh). Brit. J. Radiol.; 42: 860-2(Nov 1969).

X-ray beams produced by a linear accelerator cannot be presumed constant in time and an apparatus is described which provides a rapid method of investigating distributions in such a beam used in a medical department. The apparatus consists of five small ionization chambers, one mounted centrally and serving as a reference for the others, which are controlled in such a way as to be equidistant from the reference chamber. The outputs of the five chambers are taken to a comparator outside the treatment room, where the signal from any one of the moving chambers can be compared with the reference chamber. A photograph, circuit diagrams and brief details of the ionization chamber construction are included. (UK)

5896 SUPPRESSION OF BACKGROUND ON LONG EXPOSURE OF AUTORADIOGRAPHIC STRIPPING FILM. O'Callaghan, C; Stevens, G. W. W.; Wood, J. F. (Kodak Ltd., Harrow, Eng.). Brit. J. Radiol.; 42: 862-3(Nov 1969).

The changes of photographic properties of Kodak AR.10 autoradiographic stripping film produced by adding solutes to the transfer water were examined. Soluble potassium bromide retarded fog growth but reduced sensitivity. 20 mg/l potassium bromide was needed to keep background to 1 grain after 12 weeks, but even 10 mg/l reduced sensitivity for 24 weeks' exposure. 5% Glucose with 10 mg/l potassium bromide gave enhanced density and a very low background count. (UK)

5897 OXADIAZOLE DERIVATIVES AS SCINTILLATION SUBSTANCES. (to Ciba Ltd.). British Patent 1,164,606. Sept. 17, 1969. Priority date Sept. 15, 1965, Switzerland.

A method was developed for counting atomic disintegrations accompanied by the emission of β rays, by means of the scintillation counting method, in which an oxadiazole derivative is used as scintillator. Preparation of the oxadiazoles is described. (P.C.H.)

5898 EFFECTS OF CONTAMINANTS IN METHANE AS A PROPORTIONAL TUBE COUNTING GAS. Armstrong, F. E.; Howell, W. D.; Whitlock, D. W. (Bureau of Mines, Bartlesville, Okla.). Trans. Amer. Nucl. Soc., 12: 514-15(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5899 PULSED IONIZATION CHAMBER OUTPUT VOLTAGE CHARACTERISTICS. Imani, K.; Ellis, W. H. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 12: 516(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5900 LARGE SCINTILLATION DETECTOR FOR NEUTRON TIME-OF-FLIGHT MEASUREMENTS. Silver, E. G.; Todd, J. H.; Lewin, J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 513-14(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5901 FABRICATION OF LARGE PLANAR Ge(Li) DETECTORS. Morgan, G. L.; Owen, G. E.; Lee, Y. K. (Johns Hopkins Univ., Baltimore). Nucl. Instrum. Methods; 76: 169-70(1969).

Several new techniques in the fabrication of large area, planar Ge(Li) detectors with thin windows are described, including the use of an argon atmosphere, a simplified drifting device, and gold sputtering for windows. (auth)

5902 LIQUID SCINTILLATION SAMPLE STANDARDIZATION APPARATUS. Meeder, Raymond L.; Kus, Joseph E. (to Nuclear-Chicago Corp.). U. S. Patent 3,480,778. 25 Nov 1969. Filed 11 Apr 1966.

Liquid scintillation or similar samples within a shield forming a counting chamber are selectively exposed to a standardizing source by reciprocation of the source through a source-transport passage. Samples are introduced by a holder movable through a sample-transport passage. The source is affixed to a forwardly extending elongated shielding member. When the standard source is inserted adjacent to a sample in the chamber, the forwardly extending shielding member seats in a recess in the shield wall, and when the source is withdrawn the forwardly extending portion of the shielding member shields the chamber from the source. Specific construction for the external standardization mechanism of an automatic liquid-scintillation counting system is described. (Offic. Gaz.)

5903 Ag–Mg ELECTRON MULTIPLIER IN A SATURATED PULSE MODE OF OPERATION. Vujovic, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nucl. Instrum. Methods; 76: 171-2(1969).

A 26-stage Ag–Mg multiplier was constructed for heavy particle detection. A narrow pulse height distribution, similar to that of a channel multiplier, is obtained with a gain of about 2×10^3. Counting efficiency is discussed. (auth)

5904 CALCULATED RELATIVE EFFICIENCY FOR COAXIAL AND PLANAR Ge(Li) DETECTORS. Aubin, G.; Barrette, J.; Lamoureux, G.; Monaro, S. (Univ., Montreal). Nucl. Instrum. Methods; 76: 85-92(1969).

With the aid of a Monte Carlo computer program, the relative efficiency to monoenergetic γ-rays of coaxial and planar Ge(Li) detectors was calculated. Considering a point source, placed on the extended axis of the detector, at a fixed distance, radiations of different energies are generated within the solid angle subtended by the crystal. The gamma-rays impinging on the detector are followed until a fraction whatsoever of their energy escapes from the active region of the crystal. If the γ-ray releases all its energy in the active region, a photopeak is counted and then its ef-

ficiency is calculated. At the end of the program the efficiency for the double-escape peak is also obtained. Following this procedure the photopeak efficiency was calculated for three Ge(Li) detectors, having volumes of: 2.0 cm^3 (planar), 5.3 cm^3 and 30 cm^3 (coaxial) from ~100 keV up to 4000 keV. By means of these calculated efficiency curves, the well measured gamma-ray relative intensities in sources such as ^{22}Na, ^{88}Y, ^{207}Bi, ^{133}Ba and ThC'' could be reproduced to within 1%–3%. (auth)

5905 LOSS OF PROTONS BY NUCLEAR INELASTIC INTERACTIONS IN VARIOUS MATERIALS. Measday, D. F. (CERN, Geneva); Richard-Serre, C. Nucl. Instrum. Methods; 76: 45-54(1969).

The number of nuclear inelastic interactions of stopping protons in various materials has been calculated using the latest reaction cross-sections. The results are compared with experimental measurements of this effect in silicon, sodium iodide and plastic scintillator and an excellent agreement is found. The calculations are used to determine the loss of counts in proton telescopes due to the presence of absorbers, but the agreement with experimental measurements is satisfactory only for absorbers which are fairly thick (>50% of the range of the protons). (auth)

5906 LOSS OF PROTONS BY NUCLEAR INTERACTIONS IN SODIUM IODIDE CRYSTALS. Palmieri, J. N. (Oberlin Coll., Ohio. Harvard Univ., Cambridge, Mass.); Wolfe, J. Nucl. Instrum. Methods; 76: 55-8(1969).

An experiment is described for determining the spectrum in a sodium iodide crystal by a monoenergetic proton beam. The resulting spectrum is strongly dependent on the characteristics of the counter-telescope which precedes the sodium iodide detector. (auth)

5907 FANO FACTOR MEASUREMENT FOR SILICON USING LOW ENERGY PHOTONS. Palms, J. M.; Rao, P. Venugopala; Wood, R. E. (Emory Univ., Atlanta). Nucl. Instrum. Methods; 76: 59-60(1969).

The Fano factor in silicon at liquid nitrogen temperature is measured to be F = 0.143 ± 0.006 using photons from 6.40 to 74.97 keV. No energy dependence of the value of F is found in the range of the present measurements. Extreme care was taken to eliminate possible errors caused by electronic pulse shaping, electronic gain stability and pile-up effects. (auth)

5908 NEUTRON-CHARGED PARTICLE COINCIDENCE MEASUREMENTS FROM 14.4 MeV NEUTRON INDUCED REACTIONS. Valkovic, V.; Miljanic, D.; Tomas, P.; Antolkovic, B.; Furic, M. (Ruder Boskovic Inst., Zagreb). Nucl. Instrum. Methods; 76: 29-34(1969).

A method for measuring neutron-proton coincidences in reactions induced by neutrons is described. The possibility of measuring neutron-proton bremsstrahlung and neutron-deuteron breakup processes is also discussed. (auth)

5909 PERFORMANCE OF Si(Li) DETECTORS OVER A WIDE TEMPERATURE RANGE. Martini, M.; McMath, T. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 76: 1-10(1969).

The properties of three Si(Li) detectors have been studied over the temperature range 8.5 to 200°K. The detectors performed as high resolution spectrometers from ~50°K to temperatures determined by leakage current noise; the upper temperature limit depended on the individual detector and on the bias voltage. Best spectrometer performance was attained in the temperature range 50 to 80°K. At lower temperatures, charge collection is dominated by trapping and detrapping from shallow level traps, which have no effect on operation at 77°K. These traps may be due to the primary dopant (boron) and lithium; if so, a low temperature limit for the operation of lithium drifted devices is established. (auth)

5910 DEADTIME CORRECTIONS REDUCED BY ELECTRONICS. Fink, M. (Indiana Univ., Bloomington. Univ. of Texas, Austin). Nucl. Instrum. Methods; 76: 11-12(1969).

The deadtime of a counting system composed of scintillator, photomultiplier, window-discriminator and counter, was reduced from 20 nsec to about 2 nsec. The improvement was achieved by using the ability of the discriminator to eject more than one logic impulse depending on the duration of the photomultiplier pulse. (auth)

5911 IMPROVEMENTS IN OR RELATING TO NEUTRON DETECTORS. Kazanskaya, Valeria Andreevna; Makarov, Jury Alexandrovich; Vasilev, Stanislav Nikolaevich (to Sojuzny Nauchno-Issledovatelsky Inst.). British Patent 1,166,321. 8 Oct 1969. Filed 11 Apr 1967.

Reference is made to scintillation detectors for the measurement of thermal neutron fluxes against a background of relatively high level γ radiation. The disadvantages of some conventional phosphors for use in such detectors are enumerated, including inadequate optical transparency and hygroscopicity. The phosphor described comprises granules containing 100 parts by weight of Ag-activated ZnS and 30 to 120 parts by weight of ^6Li enriched LiF. The manufacturing process is described. The granules are between 500 and 1,000 μ in diameter, and are embedded in an optically transparent matrix, which may comprise polymethylmethacrylate, and which has a reflective coating made from magnesium titanate and a colorless lacquer on three sides. (UK)

5912 DEVICE FOR MONITORING RADIATION. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1969-18999. 18 Aug 1969. Filed 27 Dec 1965.

The radiation monitoring device proposed is used to monitor the state of formation of a radioactive material due to irradiation, e.g., in activation analysis. The advantage is to know exactly the condition of irradiation, in spite of fluctuation in time and dose of the irradiation, by monitoring the amount of produced radioactive material. The over-all device includes a radiation generator, a means located near the source for detecting the radiation, and a means for monitoring the state of irradiation by signals from the detection means. The latter means of monitoring the irradiation state is a series connection of an addition-subtraction counter, a digital-voltage converter, and a voltage-frequency converter. The output signal of the voltage-frequency converter is fed back to the addition-subtraction counter, where it is subtracted from the original input signal. The subtracted signal is used for an output signal of the means of monitoring the state; and the value obtained by adding a new input signal to the subtracted signal, is taken as an input signal of the digital-voltage converter. (NSA of Japan)

5913 PARTICLE TRACKS IN EMULSION. Katz, Robert; Kobetich, E. J. (Univ. of Nebraska, Lincoln). Phys. Rev.; 186: 344-51(10 Oct 1969).

A new theory of track formation in emulsion accounts for the tracks of charged particles on the basis of a theory developed earlier for the response of biological molecules and NaI(Tl) to energetic heavy ions. The probability that an emulsion grain will remain undeveloped when exposed to δ rays depositing a mean energy $\bar{E}$ is assumed to be $e^{-\bar{E}/E_0}$, where E_0 is the dose at which 1/e (37%) of the emulsion grains remain undeveloped, as in the one-or-more-hit cumulative Poisson distribution. The parameter E_0 incorporates variations in emulsion properties and processing conditions. Calculation of the spatial distribution of the ionization energy deposited by δ rays is combined with the assumed emulsion response to yield the spatial distribution of developed grains about the path of the charged particle. Calculations are in agreement with experimental data for grain counts (up to the relativistic rise), blackness profiles, and track width. (auth)

5914 IMPROVEMENTS IN AND RELATING TO SEMICONDUCTOR DEVICES. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,173,507. 10 Dec 1969. Priority date 1 Mar 1966, Netherlands.

A position-sensitive semiconductor detector is described which uses a multiple electrode arrangement consisting of parallel and mutually isolated electrode strips. (W.H.K)

5915 2-ARYL INDOLES AND METHODS FOR THEIR USE. Horrocks, Donald L.; Wirth, Hermann O. (to U. S. Atomic Energy Commission). U. S. Patent 3,478,208. Nov. 11, 1969.

Solutions of N-butyl-2-biphenylindole or other N substituted indoles in toluene are proposed for use as an organic scintillator for detecting and measuring ionizing radiation. (AEC)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 6474.

5916 (EUR-4269, pp 137-42) UNIVERSAL VACUUM CHAMBER FOR LITHIUM-DRIFTED GERMANIUM DETECTORS. Nitsche, E. (Siemens A.G., Erlangen (West Germany)).

The design of a vacuum chamber of small outer dimension for encapsulating germanium detectors of different shapes and sizes to be mounted horizontally or vertically is described. The vacuum chamber forms a part of a cryostat system and in certain applications it is advantageous to use a germanium detector of the suspended type. (J.C.W.)

5917 (JUL-572-RX) CALCULATION PROGRAM FOR PHOTOPEAK ANALYSIS. Meixner, C. (Kernforschungszentrum, Juelich (West Germany). Zentralinstitut fuer Reaktorexperiments). Feb. 1969. 28p. (In German). Dep. CFSTI (U. S. Sales Only).

The spectral superposition and photopeak analysis methods for the evaluation of γ spectra with a digital computer are compared. A computer program in FORTRAN IV was formulated for photopeak analysis. The program can accomplish a complete photopeak analysis with supplementary energy calculations, correction of the peak surface for photopeak yields and estimates of the possible nuclides. The program can be used for activation analysis or exact energy determination. The structure of the program and some examples of data distribution are given. (tr-auth)

5918 AN INVESTIGATION OF THE ENERGY DEPENDENCE OF THE SPECIFIC AVERAGE ENERGY LOSS PER ION PAIR IN METHANE AND HYDROGEN WITH A PROTON-RECOIL SPECTROMETER. Rogers, J. W. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 12: 936-7(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5919 PREDICTION OF WALL AND END EFFECTS IN PROTON-RECOIL SPECTROMETERS. Yule, T. J.; Bennett, E. F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 517-18(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5920 VARIANCE–COVARIANCE ASSUMPTIONS OF GAMMA-RAY SPECTRA. Eckhoff, N. D.; Haskin, F. E.; Ervin, P. F. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 12: 512-13(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5921 PLASTIC SCINTILLATION SPECTROMETER FOR HIGH-ENERGY BETA PARTICLES. Beck, E. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods; 76: 77-84(1969).

A scintillation spectrometer has been built to measure beta spectra of short-lived isotopes. The spectrometer consists of two scintillators working in coincidence. The equipment has been calibrated for both electrons and positrons up to 9 MeV using the external beam of a betatron. The resolution ΔE of the spectrometer was found to vary with energy E as $\Delta E \propto E^{\frac{1}{2}}$. The pile-up of positron pulses with pulses from Compton recoil electrons of the annihilation radiation created in the scintillator was studied in detail. Its influence on the positron end-point energy was found to be small. In order to test the spectrometer, maximum beta energies in the decay of ^{68}Ga, ^{82}Rb, ^{90}Y, ^{106}Rh, and ^{118}I were determined. (auth)

5922 A PEAK-FITTING AND CALIBRATION PROGRAM FOR Ge(Li) DETECTORS. Varnell, L.; Trischuk, J. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Instrum. Methods; 76: 109-14(1969).

A program is described for the analysis of gamma-ray spectra obtained with Ge(Li) spectrometers. To determine the energy and intensity of spectral lines, the region of the pulse height spectrum about each full energy peak is fitted to an analytic function using a least-squares computer code. The basic function used for the peak is the fold of a Gaussian with an exponential (the complementary error function). There are ten parameters in the peak function. Five of these parameters are determined as a function of energy using calibration sources and then held fixed in the fit; only the peak position, area, and the three background parameters are allowed to vary. Multiple peaks are fitted by adding additional parameters for the position and area of each peak. The efficiency calibration of the spectrometer is made using sources with accurately measured relative intensities. There are several advantages to this program over those previously reported: 1) the function used gives a better fit to the experimental peak shape, and 2) unknown sources are fitted with the same function as the calibration sources, so that any differences between the function and the actual peak shape are minimized. Using this program, relative intensities have been measured to better than one percent, and energies to better than 0.1 keV. (auth)

5923 PEAK AREA DETERMINATION FOR Ge(Li) DETECTOR DATA. Quittner, P. (Central Research Inst. for Physics, Budapest). Nucl. Instrum. Methods; 76: 115-24(1969).

Non-linear base lines have been constructed for peak area determination on Ge(Li) spectral data. The base lines are third degree polynomials whose values and slopes coincide with the smoothed spectra in regions outside the peak boundaries. By measuring gamma rays of ^{22}Na and ^{137}Cs in the presence of different ^{60}Co activities, experimental results were obtained to show how the number of points and regions used for smoothing and for peak area calculation effected the precision and accuracy of the relative intensity determinations. Equations are given for use in base line construction for any spectrum and for estimation of the statistical error in the peak area computation. The method has been compared with other peak area determination methods and with weighted least-squares spectrum resolution. The precision and accuracy of relative intensities calculated by nonlinear base line were better than those obtained by other peak area determination methods. Although the non-linear base line method was slightly less precise than the weighted least-squares resolution, it has the advantage of not requiring the measurement of each individual spectral component expected to be present in a complex spectrum; furthermore, the calculation can be accomplished much faster. (auth)

5924 APPLICATIONS OF TIME MEASUREMENTS TO CHARGED PARTICLE DETECTION IN REACTIONS WITH 14.4 MeV NEUTRONS. Miljanic, D.; Antolkovic, B.; Valkovic, V. (Ruder Boskovic Inst., Zagreb). Nucl. Instrum. Methods; 76: 23-8(1969).

A system for measuring charged particle spectra from neutron-induced reactions is described. The system consists of a counter telescope in connection with a time-of-flight apparatus and a three-dimensional analyzer. The time-of-flight measurement of a charged particle together with the measurement of its energy and energy loss allows the study of neutron induced reactions with low cross sections. (auth)

5925 FOURIER ANALYSIS OF THERMAL NEUTRON TIME-OF-FLIGHT DATA: A HIGH EFFICIENCY NEUTRON CHOPPING SYSTEM. I. Colwell, J. F.; Lehinan, S. R.; Miller, P. H. Jr.; Whittemore, W. L. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Instrum. Methods; 76: 135-49(1969).

A high efficiency neutron chopping system utilizing Fourier analysis is described. The unique advantages of this system compared to alternative systems are discussed and illustrated through the use of results both from laboratory experiments and computer experiments. The relative error of the reconstructed time-of-flight (TOF) distribution is found. It is superior to a Fermi chopper for a TOF distribution consisting of sharp peaks while it is about equivalent for a slowly varying TOF spectrum. (auth)

High Energy Physics Instrumentation

5926 (IFA-CR-58) ON THE FADING OF RELATIVISTIC TRACKS IN K-5 NUCLEAR EMULSION AT HIGH TEMPERATURE. Friedlender, E. M.; Friedlaender, J.; Marin, A.; Settles, R. D. (Academia R. S. R., Bucharest. Institutul de Fizica Atomica). 1969. 15p. Dep. CFSTI (U. S. Sales Only).

Evolution in time of the latent image fading of relativistic tracks in K-5 emulsions is investigated at a temperature typical of exposures in high intensity pulsed magnetic fields. The fading is significantly non-exponential and strong enough to cause systematic shifts and relatively wide scatters of the estimated track parameters. Plates subjected to preheating show a more regular and hence predictable fading behavior, as well as a weaker overall fading. (auth)

5927 MEASUREMENT OF GROWTH RATE FOR SUB-VISIBLE BUBBLES IN A BUBBLE CHAMBER. Harigel, G. (CERN, Geneva); Hilke, H. J.; Rogers, A.; Horlitz, G.; Wolff, S.; Fretwurst, E.; Lindstroem, G. J. Appl. Phys.; 40: 4962-6(Nov 1969).

Resonant absorption of high-frequency sound was tried as a new method for the determination of bubble growth. In the 85-cm bubble chamber at DESY, filled with a Ne/H_2 mixture (90/10 mole %) at 29°K, the growth rate of subvisible bubbles was measured with 122-kHz ultrasonics for time intervals between 10 and 70 μsec after the passage of a particle. The results were evaluated according to the theory of Trammell and were compared with an extrapolation from optically measured values under the assumption of an $R \sim t^{\frac{1}{2}}$ dependence for the bubble radius. (auth)

5928 THE FABRICATION AND OPERATION OF REMOTE FERRITE CORE READOUT WIRE SPARK CHAMBERS. Arnison, G. T. J. (RHEL, Chilton, Eng.); Watkins, I. L.; Olsen, R. Nucl. Instrum. Methods; 76: 177-80(1969).

A ferrite core wire spark chamber system is described, giving details of the chamber construction and testing methods. (auth)

5929 AMBIGUITIES OF ONE CONSTRAINT FIT EVENTS IN BUBBLE CHAMBER EXPERIMENTS. Peeters, P.; Pape, L.; Verbeure, F. (Interuniversitary Lab. for High Energy Physics, Brussels). Nucl. Instrum. Methods; 76: 125-34(1969).

In bubble chamber experiments at intermediate and high energies, a large fraction of one constraint fit events cannot be iden-

tified unambiguously. Studying this problem from the kinematical point of view, we found that certain types of ambiguity can be related to well defined regions of laboratory momentum plots. A relation is given between the χ^2 of a fit and the square of the pull on the missing mass squared of the corresponding hypothesis. This feature is used to treat the ambiguities in a rigorous way. A computer program has been written, which calculates the fractions of events, corresponding to the different ambiguities. Methods are indicated to correct the cross sections. (auth)

5930 EFFICIENT LIGHT COLLECTION IN GAS CHERENKOV COUNTERS. Osborn, R. W. (Univ. of Rochester, N. Y.). Nucl. Instrum. Methods; 76: 61-9(1969).

General formulae and two computer ray-tracing programs to simplify design of threshold Cherenkov detectors are presented. It is assumed that directional light is reflected from curved mirrors into phototubes or into additional conical reflectors which act as high transmission lenses. Given a mirror shape, the programs find position of the off-axis "focus" and optimum shape of secondary reflector. (auth)

5931 LOCATION OF PARTICLE TRACKS IN NUCLEAR EMULSION USING A WIDE-GAP SPARK CHAMBER. Kinzer, R. L.; Seeman, N.; Share, G. H. (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods; 76: 70-4(1969).

The accuracy with which particle tracks can be located in nuclear emulsions using trajectories determined by a wide-gap spark chamber has been investigated. Results indicate improvement over previous studies using narrow-gap chambers. The rms deviation of tracks from their predicted coordinates is 225 μm. The rms deviations in projected and dip angles are 0.29° and 0.47° respectively. (auth)

5932 THE INFLUENCE OF ULTRASOUND ON THE FORMATION OF HIGH-ENERGY PARTICLE TRACTS IN LIQUID HYDROGEN BUBBLE CHAMBER. Akulichev, V. A.; Gavrilov, L. R.; Grebinnik, V. G.; Zhukov, V. A.; Libman, G.; Manych, A. P.; Rozenberg, L. D.; Rudin, Yu. I.; Selivanov, G. I. Usp. Fiz. Nauk, 99: No. 1, 149-51(Sept. 1969). (In Russian).

Since 1967 cooperative studies have been carried out on the effect of ultrasound on the formation of tracks of high energy particles in a bubble chamber at the Joint Institute for Nuclear Research and the Acoustic Institute of the USSR Academy of Sciences. A barium titanate type acoustic emitter and a receiver were placed in a 25-cm liquid-hydrogen bubble chamber. Passage of a high-energy particle through the chamber was synchronized with the emission of a supersonic pulse. Photographs of the particles from the synchrocyclotron in the bubble chamber with a magnetic field of 2.5 koersted at 27°K showed clearly that the ultrasonic pulse affected the growth of bubbles indicating the track. It might be desirable to replace all of the currently used amplification systems with an ultrasonic one. (TTT)

Radiation Dosimeters

Refer also to abstract 6045.

5933 (AECL-3384) INSTRUMENT FOR MEASURING ULTRAVIOLET EXPOSURES. Osborne, R. V. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1969. 14p. Dep. CFSTI (U. S. Sales Only). AECL $0.50.

Attachment of an integrator to an ultraviolet detector allows accurate measurement of ultraviolet doses during biological exposures. The integrator may be set so that when a predetermined dose has been delivered the uv source is switched off or a shutter closed. The accuracy of integration is within 1% which is better than that of the uv detector. Variation of the integrator calibration with temperature is negligible. Procedures for using and calibrating the integrator are given. (auth)

5934 (UCRL-50007-69-2) HAZARDS CONTROL PROGRESS REPORT NO. 34, MAY-AUGUST 1969. (California Univ., Livermore. Lawrence Radiation Lab.). 62p. Dep. CFSTI.

Topics include the LRL TLD badge for personnel monitoring, automatic reading system for the TLD personnel dosimetry badges, electronics for automated TLD reader system, a monitoring system for sewage effluent, a simple field method for tritium bioassay using a proportional counter, a rapid method for determining position of sodium iodide in the detector can, and neutron scattering in the Hazards Control low-scatter cell. (W.H.K.)

5935 EXPERIMENTAL DETERMINATION OF THE ABSORBED ENERGY WITH THE AID OF GRAPHITE CALORIMETER. Ermakov, I. A. (Central Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol.; 14: No. 10, 47-53(Oct 1969). (In Russian).

A design of a calorimeter is described and the results of measurements of absorbed energy in different irradiation fields and depths in graphite phantom are reported. Calorimetric measurements were compared with ionization ones in which the Baldwin-Farmer dosimeter chambers were placed in the same point of the medium as was the absorber. (auth)

5936 THERMAL QUENCHING OF LUMINESCENCE IN SIX THERMOLUMINESCENT DOSIMETRY PHOSPHORS. I. QUENCHING OF X-RAY-EXCITED RADIOLUMINESCENCE. Gorbics, S. G.; Nash, A. E.; Attix, F. H. (Naval Research Lab., Washington, D. C.). Int. J. Appl. Radiat. Isotop.; 20: 829-41(Dec 1969).

The role played by the thermal quenching of luminescence in thermoluminescent (TL) dosimeters had not been investigated previously. If thermal quenching is operative in the temperature region of the glow-peak, changes in heating rate which cause the temperature position of the peak to change would result in non-constant light sums. The direct measure of the TL light sum or the glow-peak height as a function of heating rate is technically difficult. The main problem is that the phosphor temperature tends to lag behind the heating-planchet temperature by an amount which is a function of the heating rate and the degree of thermal coupling. Thus a thermocouple attached to the planchet provides an erroneous measure of the phosphor temperature. This problem was side-stepped in studying the thermal quenching of the X-ray-excited radioluminescence under static thermal conditions. Because of the observed similarity of such emission spectra to the corresponding thermoluminescence spectra, the emitting centers involved in both processes were probably the same for each phosphor studied. The resulting curves of brightness vs temperature were found generally to exhibit large discontinuities in the vicinity of the TL glow-peak temperatures, and were therefore difficult to interpret in terms of quenching of thermoluminescence. (auth) (UK)

5937 THERMAL QUENCHING OF LUMINESCENCE IN SIX THERMOLUMINESCENT DOSIMETRY PHOSPHORS. II. QUENCHING OF THERMOLUMINESCENCE. Gorbics, S. G.; Nash, A. E.; Attix, F. H. (Naval Research Lab., Washington, D. C.). Int. J. Appl. Radiat. Isotop.; 20: 843-52(Dec 1969).

Since the results of the measurement of the X-ray-excited radioluminescence as a function of temperature of TL dosimetry materials were difficult to interpret in terms of quenching of thermoluminescence, a direct measurement was made of the TL light sum and the glow-peak height as a function of heating rate. In order to overcome the problem of thermal lag between the heating planchet and the phosphor, a method was developed to achieve a high degree of thermal coupling by mixing powdered phosphor and gold and pressing the mixture to the surface of a gold disk. The glow curves from these gold plaques were recorded with a reader that produced heating programs which were linear to a few percent from rates of 4°C/min up to 640°C/min. By this technique glow-peak heights and light sums were measured for CaF_2 : Mn, natural fluorite, LiF(TLD-100), $CaSO_4$: Mn, $Li_2B_4O_7$: Mn, and terbium-activated lithium aluminosilicate glass over the full range of heating rates. Considerable variability was found in the thermal quenching characteristics of the various phosphors. All but the fluorite and the $Li_2B_4O_7$: Mn showed some decrease in light output at high heating rates. LiF also exhibited a decrease for low heating rates, with a broad maximum in the light output at about 100°C/min. (auth) (UK)

5938 REPORT ON A MEETING ON THE USE OF SOLID STATE AND OTHER DOSIMETERS IN RADIOTHERAPY HELD AT THE BRITISH INSTITUTE OF RADIOLOGY, LONDON, FEB. 1969. Brit. J. Radiol.; 42: 870-2(Nov 1969).

The following subjects were briefly discussed in a single two hour meeting: Ionization methods, thermoluminescence, phosphate glass dosimetry, semiconductor devices, and pattern dosimetry. (UK)

5939 INTEGRAL THERMAL FLUX CALORIMETER. Korotenko, M. N.; Nazarchuk, M. M.; Ogoradnik, S. S.; Rebchinskii, A. V.; Slesorvskii, S. O.; Stelmakh, S. S.; Tsoglin, J. L. (to Institut Fiziki). British Patent 1,171,506. 19 Nov 1969. Filed 4 Jul 1967.

The calorimeter described is claimed to provide high accuracy of measurement over low thermal inertia, and does not require use of an auxiliary thermostat; high sensitivity and an extended measurement range are also claimed. The instrument also makes it possible to measure heat generation with samples of any desired shape. The calorimeter comprises a closed measuring chamber built up of at least one layer of adjacent thermoelectric converters, the latter consisting of local thermal flux transducers, connected together electrically. The transducers produce an output signal representative of the rate of thermal flux through them. The layers

of thermoelectric converters may be connected in series or in parallel. (UK)

Radiometric Instruments

5940 (RLO–1543-5) WATER CONTENT MEASUREMENT BY NEUTRON ATTENUATION FOR APPLICATION TO STUDY OF UNSATURATED FLOW OF SOIL WATER. Stewart, Gordon L.; Gardner, Walter H. (Washington State Univ., Pullman. Dept. of Agronomy). [1969]. Contract AT(45-1)-1543. 26p. Dep. CFSTI.

Adequate testing of the applicability of various equations to studies of unsaturated water flow in soil requires a precise method for water content measurement. A neutron-matter interaction technique has been developed to measure water contents of small volume elements of soil accurately, rapidly, and at frequent time intervals. This method can be used to measure water content in many types of experiments but it is particularly well suited for experiments involving transient flow. High thermal neutron fluxes, available at the present time only from nuclear reactors, are required. The method is superior to existing methods for measuring, nondestructively, water content as a function of time and position. The inherent precision due to the random nature of neutron production with a neutron count in dry soil of 6×10^5 c/m, for 2 second counting and a resolution of 1 mm by 1 cm for dry and wet water content regions (about 5% and 40% water) are about ±0.2% and ±0.4% water. For 30 second counting times the precisions improve to about ±0.05% and ±0.1% water. Longer counting times would lead to further improvement. Neutron attenuation is not seriously affected by density changes but soil bulk density can be measured by use of long counting times. Precision for soil bulk density measurement is about ±0.002 gm/cm^3 with counting times of about 200 seconds. With improved techniques and fluxes available at a 100 kW reactor it appears possible to improve the present resolution by a factor of 10 beyond that reported here. (auth)

5941 DESIGN AND PERFORMANCE OF A MOVING GAMMA-SOURCE SOIL DENSITY GAUGE. Devlin, G.; Henderson, I. A.; Taylor, D. (Univ. of Strathclyde, Scotland). Nucl. Instrum. Methods; 76: 150-6(1969).

In the moving source method of measuring soil densities proposed in an earlier communication, the source-detector separation d is adjusted to maximize Id^n, where I is the counting rate and the index n is a constant value >1. If d_m is the optimum source-detector separation and ρ is the density of the soil under investigation, theory indicates that $\rho d_m = (n-1)/k$ = a constant, and hence measurement of d_m allows a determination of the soil density ρ. A prototype of this new form of instrument has been constructed and operates as expected, providing that the direct radiation from source to detector is a negligible proportion of the radiation scattered back from the soil, and this condition is maintained over the range of d-values employed. The instrument displays the expected characteristics, namely that Id^n–maxima are obtained at the expected d-values, and allows measurement of density to a precision better than ±1%. Typical performance characteristics are given for a number of common materials. An important component of the instrument is the output unit for computing Id^n, which takes the form of a pulse generator of adjustable frequency f, feeding through a number m of decade dividers, and controls the time interval for the count for each d-value. The total count $I_t = 1 \times 10^{m/f}$, and so if $10^{m/f}$ is made equal to d^n for each d-value, I_t is = Id^n. One commercial form of universal counter allows this form of computation to be carried out easily and conveniently and this has been used. The new instrument allows density measurements to be made quickly and easily and is considered to be an improvement over the older fixed-d systems. (auth)

5942 IMPROVEMENTS IN OR RELATING TO INSTRUMENTS FOR RADIATION MEASUREMENT. Jordan, Brian Jerrold (to Saunders-Roe Developments Ltd.). British Patent 1,171,173. 19 Nov 1969. Filed 9 Sep 1966.

The object is to provide an instrument which recalibrates at frequent intervals, detects variations due to drift and sensitivity changes, and reduces the effect of such variations by stabilizing circuitry. The apparatus is intended primarily for investigating radiation attenuation by materials. It comprises a primary radioactive source, a second standardizing radioactive source, a phosphor for detecting radiation from the primary source after passing through a material and a second phosphor for detecting radiation from the second source; also a radiation sensitive detector and interrupter means for alternately transmitting radiation from the phosphors to the detector is incorporated. The associated circuitry compares the difference of the alternate signals emitted by the detector with their mean value to provide a signal which is a function of radiation attenuation through the material. The attenuated radiation and the reference radiation may be transmitted to phosphors whose scintillations are sensed by a comparator system. The cyclic measurements may be carried out by use of a resolving source and shutter. The comparator system may include a photomultiplier whose output is fed to an amplifying system, the mean output of which is maintained substantially constant by automatically adjusting the gain. A phase-sensitive demodulator and indicator means may also be provided. (UK)

Miscellaneous Instruments and Components

Refer also to abstracts 5761, 5828, 6303, and 7167.

5943 (BNWL–1168) CONTINUOUS MONITOR FOR HEXAVALENT CHROMIUM IN RIVER WATER. Alton, D. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 47p. Dep. CFSTI.

A continuous monitor for hexavalent chromium was developed and placed in routine operation at the Automatic Columbia River Monitor Station (ACRMS), located at the 300 Area of Hanford, approximately 4 miles upstream from the nearest public water supply intake. Basically, the unit is commercially available equipment which uses a colorimetric method for continuous determination of Cr^{+6} concentrations in river water. With a modified water filtration system and other changes, Cr^{+6} in river water as low as 2 to 3 parts per billion can be measured reliably. A remote alarm system preset to actuate at a Cr^{+6} concentration of 25 ppb, provides the necessary time interval to enable water plants downstream to discontinue intake. (auth)

5944 (CEA-R–3916) TEMPERATURE MEASUREMENTS INSIDE NUCLEAR REACTOR CORES. Tarassenko, Serge (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1969. 107p. (In French). Dep. CFSTI (U. S. Sales Only).

Non-negligible errors can often be made in the measurement of temperatures in a nuclear reactor with micro-conductor thermocouples insulated with magnesium oxide and canned in stainless steel, when these circuits are placed under operational conditions which are typical of those existing in power stations, producing electrical energy. It is shown that this error is due principally to electrical hysteresis and polarization phenomena in the insulator subjected to the strong fields created by the common-mode voltages. These phenomena favor the unsymmetrical flow of the common-mode current and thus lead to the formation of a differential-mode voltage which is to be added to the thermoelectric voltage produced by the hot junction. By calculation and an experimental approach it is possible to show the important role played by the insulating characteristics of the insulator, the isolation of the hot junction, the choice of the main circuits in the information processing equipment as well as the performances under conditions of galvanic isolation, and for the case of rejection of the common-mode of the complete measurement installation. A justification is thereby given for the severe conditions imposed for the acceptance of thermo-electric materials. Some particular precautions to be taken are described, as well as the high performance characteristics which have to be taken into consideration in choosing measurement systems linked to thermometric circuits containing micro-conductors. (auth)

5945 (DP–1193) IMPROVED URANIUM COLORIMETER. Stutheit, James S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jun 1969. Contract AT(07-2)-1. 12p. Dep. CFSTI.

Savannah River Plant colorimeters used to monitor continuously liquid streams containing 0 to 10 grams of uranium per liter of solution have been redesigned to give uranium analysis correct within ±0.5 grams/liter. In the redesign, solid state logarithmic amplifiers, magnetic amplifiers, and closely regulated power supplies were used to achieve accuracy and stability. Meter and recorder indications were made linear to read in grams/liter of uranium. The optical portion was modified so the colorimeter could be calibrated without removing the sample cell. (auth)

5946 (IFA-EN–11) WEIGHTED CHRONOTRON FOR TIME-DIGIT CONVERSION. Feran, Monica; Katz, E.; Papina, R. (Academia R. S. R., Bucharest. Institutul de Fizica Atomica). 1969. 16p. Dep. CFSTI (U. S. Sales Only).

A time interval is measured by counting the integer number of

periods of a delay line generator with taps at weighted intervals, iteratively swept by a START pulse. The remainder of the time interval is measured by iteratively circulating START and STOP pulses through the weighted portions of the line and successively subtracting and registering them. (auth)

5947 (UCRL-50738) AUTOMATED INSTRUMENTATION SYSTEM FOR MASS SPECTROMETRIC GAS ANALYSES. Crawford, Richard W.; Stump, Ronald K.; Ernst, Klaus (California Univ., Livermore. Lawrence Radiation Lab.). 27 Aug 1969. 17p. Dep. CFSTI.

An automated instrumentation and data acquisition system that analyzes gases by mass spectrometry is described. This system continuously monitors chemical reactions in several closed reaction vessels by automatically sampling and analyzing the gas compositions at predetermined, but variable, time intervals. Mass spectral data are recorded on an oscillograph recorder. Simultaneously, mass-number and peak-height information is digitized, printed out, and punched on a fast paper-tape punch. (auth)

5948 RADIO CHROMATOGRAM READING APPARATUS. Wagner, Vittoriano; Forcheri, Sandro (to EURATOM). British Patent 1,170,157. 12 Nov 1969. Priority date 26 Feb 1966, Italy.

A radiochromatography reading apparatus is described, comprising a Geiger--Mueller counter, a specimen mount enabling the chromatogram to be displaced normally to the counter axis, and a collimator between the counter and specimen. (W.H.K.)

5949 CALIBRATION SYSTEM FOR A PULSE NUCLEAR INDUCTION SPECTROMETER. Mahon, Harold P. (Univ. of Massachusetts, Boston). Rev. Sci. Instrum.; 40: 1644-5(Dec 1969).

A calibrator is described which produces a pulse signal of a given input frequency and amplitude at the input of a nuclear induction spectrometer. The calibration system consists of an rf source and pulse generator, a gate, and a calibrated attenuator. When the gate is turned on by a pulse of a given width, an rf pulse, generally of the same frequency as the magnetic resonance signal, is applied to the sample coil and appears at the input of the NMR receiver. By varying the relative amplitude of the rf pulse and the time at which it occurs, various performance determinations of the NMR system may be made. (W.H.K.)

5950 ROTATABLE 15 kOe SUPERCONDUCTING HELMHOLTZ COILS. Williamson, S. J. (North American Rockwell Corp., Thousand Oaks, Calif.). Rev. Sci. Instrum.; 40: 1632-4(Dec 1969).

A pair of superconducting coils in an approximate Helmholtz configuration is described which is capable of producing a magnetic field intensity in excess of 15 kOe with a homogeneity of ±0.1% within 0.5 cm of the field center and ±1.0% within 1.5 cm. The pair is mounted and geared so as to produce a horizontal field whose direction can be rotated 360° about a vertical axis. The magnet assembly has a 2.90 cm diam vertical access hole for a sample mount and can be accommodated within a 12.7 cm i.d. Dewar. (auth)

5951 LOW PRESSURE IONIZATION GAUGE. Swingler, D. L. (CSIRO Chemical Labs., Clayton, Victoria). Rev. Sci. Instrum.; 40: 1552-4(Dec 1969).

An ionization gauge is described which uses an ion gun designed for end extraction. An out-of-sight ion collector is used to extend the x-ray limit normally present in simpler structures. The gauge head has a sensitivity of 60 $Torr^{-1}$ without a secondary suppressor electrode or 20 $Torr^{-1}$ with a secondary suppressor. The gauge head is not difficult to make, uses a simple power supply, and does not require any focusing adjustment. Ion trajectories, plotted by a digital computer, are used to give an insight into the efficient operation of the structure. (auth)

5952 A HIGH RESOLUTION CHARGE AND MOBILITY SPECTROMETER FOR RADIOACTIVE SUBMICROMETRE AEROSOLS. Megaw, W. J.; Wells, A. C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., E (London); 2: 1013-16(Dec 1969).

A simple and easily constructed spectrometer is described by which it is possible to measure the electrical mobilities of submicrometre radioactive aerosol particles with an estimated absolute accuracy to ±4% and a relative accuracy to ±0.5%. The resolution of the instrument is 3% in mobility. (auth) (UK)

5953 DEVELOPMENT OF AN IONOSPHERIC CRITICAL FREQUENCY RECORDER. Chakraborty, R. C. (Bengal Engineering Coll., Howrah, India). Int. J. Electron.; 25: 585-90 (Jun 1969).

The group retardation method of vertical sounding of the ionosphere gives series of P'-f records known as "ionograms." The critical frequency is computed after developing, fixing and scaling of the ionograms. This causes delay and fails to probe into the conditions of the ionospheric regions between two intervals of recording. An attempt to develop an apparatus which will record continuously the variation of critical frequency with time during normal as well as abnormal periods is described. (auth) (UK)

5954 APPARATUS FOR DIMENSIONAL MEASUREMENTS IN A HOT CELL UTILIZING DIAL INDICATORS AND PNEUMATIC READOUT. Chandler, T. L.; Parsley, W. B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 858(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5955 DEVELOPMENT AND LOOP TESTING OF A NEW ELECTROCHEMICAL OXYGEN METER FOR SODIUM. Berkey, E. (Westinghouse Research Labs., Pittsburgh); Reed, W. H.; Grundy, B. R.; Cooper, M. H. Trans. Amer. Nucl. Soc., 12: 609-10(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5956 VACUUM PYCNOMETER USING MERCURY WITH PLUNGER DISPLACEMENT FOR HOT CELL USE. Dismuke, S. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 845(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5957 RADIOACTIVE SOURCE AND METHOD OF MANUFACTURE THEREOF. Drabkina, L. E.; Mazurek, J. V.; Myasoedov, D. N.; Prokhorov, V. P.; Kackalov, V. A.; Ziv, D. M. British Patent 1,170,913. 19 Nov 1969. Filed 10 Jul 1968.

The manufacture of radioactive sources having a sealing layer comprised of an oxide film of Ti, Sn, Zr, Al or Cr, singly or in combination, is described. This film is preferably produced by hydrolysis of the metal chlorides, by water, in contact with a heated radioactive layer applied to the substrate; the chlorides and water are preferably in vapor form. The substrate may have an enamel coating, and the radioactive layer may be a mixture of radioactive material and enamel. The substrate may be a glazed ceramic material or steel. The radioactive layer may be applied in the form of a mixture of enamel and radioactive oxide and fused with a previously applied enamel layer; such a mixture may be applied by electrophoresis. This radiation source is designed primarily for removing electrostatic charges or for calibrating radiation measuring instruments. (UK)

5958 LOW IMPEDANCE PASSIVE INTEGRATOR FOR FAST PULSES AT HIGH VOLTAGE. Leroux, J. (CERN, Geneva). Nucl. Instrum. Methods; 76: 164-8(1969). (In French).

A passive integrator was developed to meet the following requirements: integration without deformation of hv pulses (2 kV) with short rise time (125 ps) and a long time constant (100 μs). The input and output are matched for coaxial cables. (auth)

5959 SIMPLE PRECISION FLUXMETER. Sasaki, H. (Tokyo Univ.). Nucl. Instrum. Methods; 76: 100-2(1969).

A flip-coil fluxmeter coupled with an integrating digital voltmeter was developed. With small modification of the digital voltmeter, high precision with the sensitivity of several milligauss was obtained without any elaborate mechanical device for flipping the search coil. Measuring accuracy as good as a few parts in 10^5 can be achieved at the hundred gauss region with simple treatment of the fluxmeter. (auth)

5960 A SIMPLE METHOD FOR PULSE-HEIGHT ANALYSIS WITH A SINGLE-CHANNEL ANALYZER BY TEMPORAL FLUCTUATING PARTICLE INTENSITY. Greupner, H.; Bernhard, F. (Humboldt-Univ., Berlin). Nucl. Instrum. Methods; 76: 43-4 (1969). (In German).

A simple circuit to receive pulse height distributions with a single-channel analyzer is described in case of a temporal fluctuating total particle intensity. (auth)

5961 QUANTUM ELECTRONICS. VOLUME 2. MASER AMPLIFIERS AND OSCILLATORS. Sanders, J. H. (ed.). International Series of Monographs in Natural Philosophy. Volume 14. Cambridge, Mass.; Massachusetts Institute of Technology Press (1969). 328p. $16.50.

Translation of Part II of Kvantovaya Radiofizika by V. M. Fain and Ya. I. Khanin. Translated by H. S. H. Massey.

Topics include paramagnetic maser amplifiers, maser oscillators for the microwave range, lasers, laser resonators, and the spectra of paramagnetic crystals. (W.H.K.)

5962 QUANTUM ELECTRONICS. VOLUME 1. BASIC THEORY. Sanders, J. H. (ed.). International Series of Monographs in Natural Philosophy. Volume 13. Cambridge, Mass.; Massachusetts Institute of Technology Press (1969). 330p. $16.50.

Translation of Part I of Kvantovaya Radiofizika by V. M. Fain and Ya. I. Khanin. Translated by H. S. H. Massey.

Topics include the quantum theory of the interaction of radiation with matter, the quantum theory of relaxation processes, quantum effects appearing in the interaction of free electrons with high-frequency fields in resonators, the behavior of quantum states in weak fields, the behavior of quantum states in strong fields, spontaneous and stimulated emission, spontaneous and stimulated emission in free space, emission in a resonator, and non-linear effects in optics. (W.H.K.)

5963 BASIC NUCLEAR ELECTRONICS. Chiang, Hai Hung. New York; John Wiley and Sons, Inc. (1969). 351p. $14.95.

A basic introduction to the resistor, capacitor, and inductor is presented, and their interconnection for high-pass and low-pass filters is described. Also, an introduction to tubes and transistors used in basic logic circuits and amplifiers is given. The basics of pulse amplifiers, single-channel analyzers, and multichannel pulse-height analyzers are discussed. Also, typical gamma and charged-particle detectors and their associated counting circuits are described. (W.H.K.)

5964 PROFILE MEASUREMENT OF FINNED STEEL TUBING. Wells, F. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 124-32 of Proceedings of Conference on Automated Inspection for Defects and Dimensions, Eastbourne, England, 6-7th May 1969. London; Helger Ltd., 1969.

A method of profile measurement is described which was applied to the measurement of the shape of small annular cooling fins on the long stainless steel tubing used for nuclear reactor fuel elements. A cathode ray tube is employed to generate light to illuminate the object being measured, and a curve following technique is used to cause the focused spot of light to scan the profile. Comparison is made with the standard optical profile projection system. (UK)

5965 ELECTRON GUN FOR AN ION SOURCE. Mitani, Eisuke (to Hitachi Ltd.). Japanese Patent 1969-16079. 16 Jul 1969. Filed 28 Jul 1965.

An electron gun for measurement of the ionizing voltage of molecules is described. The electron gun consists of an electron-emitting filament, the first grid, one end open, surrounding the filament, the second grid for extracting emitted electrons, the third grid to which the bias voltages are applied, the fourth grid to pulse the electron beam, and the fifth grid at a suitable voltage. The four grids, are all contained in this fifth grid to shield against the external electric field. The width of slits in the grids (except the first) increases toward the ionization chamber. (NSA of Japan)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 6318.

5966 (BNWL-1137) EFFECTS OF IONIZING RADIATION ON STABILIZED PHOTO OPTICS. Kleinpeter, J. H.; Clare, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 30p. Dep. CFSTI.

Several nonbrowning lenses were tested for useful life in a radiation field. Included in the test were a 30-150 mm variable focal-length or "zoom" lens, fixed focal-length lenses in ½-in. f/2.5, 1-in. f/2.5 and 4-in. f/2.5 sizes, and suitable controls of conventional glass. All the nonbrowning lenses were useful beyond 10^9 rad total integrated dose, and the 1-in. f/2.5 was usable after 2×10^{10} rad. Coupons of the glasses used in the manufacture of these lenses were irradiated and tested for changes in refractive index and visible light transmission. (auth)

5967 (GA-9653) RELIABILITY OF HIGH-TEMPERATURE THERMOCOUPLES IN IRRADIATION CAPSULES. Sandefur, N. L.; Carpenter, F. D.; Grenda, R. J.; Steibel, J. S. (Gulf General Atomic, Inc., San Diego, Calif.). 18 Sep 1969. Contract AT(04-3)-167. 33p. (CONF-690910-7). Dep. CFSTI.

From Symposium on Developments in Irradiation Testing Technology, Sandusky, Ohio.

A study of thermocouple behavior and reliability in irradiation capsules was conducted. The investigation covered 16 instrumented (lead-tube type) capsules, which contained a total of 200 Chromel-Alumel and tungsten-rhenium sheath-type thermocouples. The history of each thermocouple was recorded from the time of receipt to insertion in an experiment and during its operating life within the irradiation capsule. Testing conditions ranged from low neutron exposures to a total fluence of 4.5×10^{21} n/sq cm (E > 0.18 MeV) with operating temperatures to 1800°C. The test data were tabulated into a computer code designed to evaluate thermocouple performance as a function of: (1) neutron exposure; (2) operating temperature; (3) time at temperature; (4) thermocouple type (Chromel-Alumel, tungsten-rhenium); (5) type of hot junction (capped or plugged, grounded, isolated); (6) manufacturer; (7) commercial construction versus construction to Gulf General Atomic specification; and (8) position of thermocouple within the capsule. From these data, correlations were deduced concerning the in-pile behavior of the thermocouples and the probability of their successful operation. Postirradiation continuity and metallographic analyses were conducted on selected thermocouples to help establish location and/or causes of failure. The computer analyses revealed that a 30% to 40% thermocouple failure rate can be expected under any set of conditions examined. The probability of failure was greater with increasing neutron exposure and longer times in the reactor. Thermocouples purchased to a Gulf General Atomic specification covering materials procurement and thermocouple manufacturing did not perform better than commercial production thermocouples for nuclear service. (auth)

5968 MODEL FOR RADIATION-INDUCED CHARGE TRAPPING AND ANNEALING IN THE OXIDE LAYER OF MOS DEVICES. Gwyn, C. W. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 40: 4886-92(Nov 1969).

A model is proposed to explain radiation damage and charge trapping in the oxide layer of MOS devices after exposure to ionizing radiation. This model is based upon the close similarity between radiation effects in the silicon dioxide layer and in fused silica. In addition to explaining the production of damage by ionization, the model has an advantage over other models inasmuch as the charge trapping in a relatively impurity-free silicon dioxide layer can be explained. The model explains radiation-induced charge trapping in the oxide and subsequent annealing of the charge as a function of temperature and exposure to ultraviolet radiation. In addition, the model suggests that the sensitivity of MOS devices to ionizing radiation can be reduced by decreasing the amorphous structure of the oxide. (auth)

5969 DEPENDENCE OF THERMOLUMINESCENT GLOW CURVE SHAPE ON THE HEATING RATE. Lee, Hee Yong (Atomic Energy Research Inst., Seoul); Kim Hi Gyu. J. Korean Phys. Soc.; 2: 72-8(Sep 1969).

The dependence of the glow curve shape on the heating rate in thermoluminescent measurements has been investigated with γ-irradiated α-quartz. Samples were heated almost linearly by the heat capacities of the furnace and the sample at a predetermined heater voltage. The dosimetric application of the method to thermoluminescence measurement, in which the heater switch is cut off at near thermal equilibrium (the so-called K-point cut off method), is discussed. The causes of distortion of the glow curves are also discussed. (auth)

5970 RADIATION HAZARDS TO APOLLO TELESCOPE MOUNT PHOTOGRAPHIC FILM. Hill, C. W.; Davis, D. N.; Parker, H. K. Jr. (Lockheed-Georgia Co., Marietta). Trans. Amer. Nucl. Soc., 12: 966-7(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

5971 MODIFICATIONS OF PROPERTIES OF THE METAL-OXIDE-SEMICONDUCTOR STRUCTURE BY ELECTRON IRRADIATION. EFFECTS OF A CONTINUOUS POLARIZATION VOLTAGE IMPRESSED DURING THE IRRADIATION. Courat, Jean-Pierre; Sixou, Pierre (Laboratoire de Physique Electronique, Orsay, France). Compt. Rend., Ser. B, 268: 1778-81 June 30, 1969). (In French).

The effect of a continuous polarization voltage impressed during an irradiation (electrons: energy 1 MeV, dose 10^{15} e/cm^2) on the complex area of an MOS structure the latter being characterized by a continuum of relatively high surface density states (several 10^{12} eV^{-1} cm^{-2}) is studied. Whatever the voltage may be, the density of states is only slightly modified by the irradiation (factor of the order of 1.5). (tr-auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 6029.

Basic Processes

Refer also to abstracts 5604, 5623, and 6072.

5972 (STI/PUB-190) ISOTOPES AND RADIATION IN SOIL ORGANIC-MATTER STUDIES. Proceedings Series. Proceedings of the Symposium Held in Vienna, 15–19 July 1968. (International Atomic Energy Agency, Vienna (Austria)). Dec. 1968. 593p. (In several languages). (CONF-680725). IAEA: $13.50.

Separate abstracts were prepared for five of the 48 papers presented in this symposium. The other 43 papers discuss the use of routine tracer techniques in relation to laboratory techniques for studying soil organic matter, properties of soil organic compounds, studies of nitrogen transformations in soils using ^{15}N, organic-matter synthesis and decomposition in soils, organic matter in tropical soils, and organic-matter effects on nutrient availability in soils. Discussions are included, in English, at the end of each paper. (E.R.B.)

For abstracts of individual papers see: 5604, 5659, 5684, 5976, and 6016.

5973 METHOD FOR THE DIRECT ESTIMATION OF THE LENGTH OF G1, S, AND G2 PHASE. Maekawa, T.; Tsuchiya, J. (Gunma Univ., Maebashi, Japan). Exp. Cell Res., 53: 55-64 (Oct. 1968).

A method for direct estimation of the mean length of G1, G2, and S phase in vivo using the simultaneous administration of ^{3}HTdR and Colcemid is described. Using this method, cell cycles of both basophilic erythroblasts and Yoshida sarcoma cells were analyzed. The mean length of G1 phase was found to be 2 and 9 hr respectively, G2 and S phase of the sarcoma cells were 2 and 13 hr respectively. No dormant cells were found in the basophilic erythroblasts, while 16.5% of the sarcoma cells were dormant. (auth)

5974 NEUTRON-ACTIVATION TECHNIQUE OF RADIATION OF MICRODISTRIBUTORS OF STABLE IODINE IN THE THYROID GLAND. Ryabukhin, Yu. S.; Melnik, A. D.; Tkachev, A. V.; Zaichik, V. E. (Inst. of Medical Radiology, Moscow). Med. Radiol.; 14: No. 10, 5-8(Oct 1969). (In Russian).

The technique is based upon the activation of sections of the thyroid gland with supracadmium neutrons with the subsequent employment of autoradiography. The source of supracadmium neutrons served a reactor with a beam of thermal neutrons at the irradiation sites of sections equalling $1 \cdot 10^{12}$ n/cm^2 sec. The gamma-spectra and radioautographs of irradiated samples of the thyroid gland, which illustrate the irregularity of microdistribution of stable iodine in the thyroid gland, are presented. (auth)

5975 RADIOIMMUNOASSAY OF URINARY HCG AND ITS CORRELATION WITH BIOLOGICAL ACTIVITY. Ishizuka, Naotaka; Tomoda, Yutaka (Nagoya Univ., Japan). Horumon To Rinsho, 17: 644-9(Aug. 1969). (In Japanese).

The performance of radioimmunoassay (RIA) in the analysis of biological activities of human chorionic gonadotropin (HCG) was evaluated. The bioassays used in the comparative study included mouse uterine weight method for the measurement of total gonadotropin activity, rat seminal vesicle weight method for LH activity, and rat ovarian weight method for FSH activity. The HCG value obtained by RIA was close to the results of the hemagglutination inhibition test. The correlation between RIA values and bioassay values proved to be high in general. However, discrepancy was observed in the ratio of biological and immunological activities (B/I) of urinary HCG studied in individual case of normal pregnancy and chorionic tumors. The B/I ratio was rather low in hydatid mole, high in normal pregnancy, similar in destructive mole, and highest in chorionic epithelioma. The FSH activity was found to be low in contrast to high LH activity, which was well represented in RIA. (NSA of Japan)

5976 PHYTIN UTILIZATION BY PLANTS. Fardeau, J.-C.; Delille, D.; Abramovici, C. (CEN, Cadarache, France). pp 555-65 of Isotopes and Radiation in Soil Organic-Matter Studies. Vienna, International Atomic Energy Agency, 1968. (In French).

From Symposium on the Use of Isotopes and Radiation in Soil Organic-Matter Studies, Vienna, Austria. See STI/PUB-190; CONF-680725.

Pot experiments were carried out over a three-month period with an argillocalcareous soil to study the effect of sodium hexaphosphate inositol on rye-grass growth. While the increase in dry-matter yield was only significant after the second cutting, a large increase in phosphorus content (212%) was observed even at the first. In the absence of direct labeling of phytin, which could not be done by activation, an inverse isotopic dilution procedure, based on the Fried and Dean method and involving the labeling of the soil phosphorus, was used to follow the mode of action of the compound; the absence of isotopic exchange between $^{32}PO_4^{3-}$ ions and the phosphoric groups in the phytin observed in an aqueous solution justified the use of this technique. It showed that additional phosphorus uptake by the plants does in fact originate in the progressive release of the phytin phosphoric groups and not, for example, in stimulation of the root systems promoting better soil exploration. (auth)

5977 RADIOIMMUNOASSAY OF ANGIOTENSIN II AND ITS PROBLEMS. Kaihara, Shigekoto; Ueda, Hideo (Tokyo Univ.). Igaku No Ayumi; 70: 220-4(Aug 1969). (In Japanese).

The radioimmunoassay of Angiotensin II (A-II) is described in terms of labeling, antibody production, and isolation. The mixture of 15mCi of ^{125}I, 5 μg of A-II and 25 μg of chloramin T yielded ^{125}I-labeled A-II with high specific activity. Antibody was prepared from 0.5 ml of 10% carbodiimide solution, 25 mg of A-II, and 20 mg of rabbit serum albumin (or pig gamma-globulin), left for 15 to 30 minutes in room temperature, and dialyzed for injection into rabbits. The coated tube method was used for isolation. Radioimmunoassay was performed with A-II extracted from the plasma isolated in a freezing sedimentator. The concentration of A-II in the peripheral venous circulation of normal human subjects was 55 ± 20 pg/ml. The problems associated with radioimmunossay of A-II include: specificity of antibody, and use of synthetic A-II which may result in a difference from natural A-II. The comparative study of radioimmunoassay with bioassay indicated that EDTA used for inhibition of angiotensinase also exercised an inhibitory action on the enzyme that converts A-I to A-II, and that the determination of renin activity should be conducted without EDTA. For its simplicity and high sensitivity, the potential use of the method as a routine clinical test is suggested provided more clinical data is accumulated. (NSA of Japan)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 6034, 6042, and 6069.

5978 (ORNL-4445) THE BALANCES OF ^{137}Cs, STABLE CESIUM, AND THE FEEDING RATES OF BLUEGILL (LEPOMIS MACROCHIRUS RAF.) IN WHITE OAK LAKE. Kolehmainen, S. E.; Nelson, D. J. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 127p. Dep. CFSTI.

Thesis. Submitted by S. E. Kolehmainen to Univ. of Tennessee, Knoxville.

The concentration of ^{137}Cs, stable cesium, and potassium and the specific activities of ^{137}Cs were determined in seven species of fish in White Oak Lake, a small radioactively contaminated lake in Oak Ridge, Tennessee, during a period from June of 1967 to January of 1969. The intake of ^{137}Cs was used to calculate the feeding rates of bluegill at different times of the year. The concentration of ^{137}Cs in bluegill and other species of fish as well as in the food of bluegill was analyzed γ-spectrometrically. Concentrations of stable cesium and potassium were analyzed by flame spectrophotometry after a chemical separation. The concentration of ^{137}Cs in bluegill increased by a factor of four in fish from 1 to 70 g, but the concentration of stable cesium decreased somewhat with increasing fish size. In bluegill above 70 g the concentration of ^{137}Cs was in a steady state with a considerable seasonal cycling, and the concentration of stable cesium in large bluegill had a seasonal cycling similar to that of ^{137}Cs. Concentrations of potassium also decreased slightly with increasing fish size, but the concentration of potassium did not fluctuate seasonally. The excretion rates of cesium and potassium were determined by biological half-life studies using ^{137}Cs and ^{42}K. The biological half-life of ^{137}Cs increased with the increasing size of bluegill. There were no significant differences in the long component of the biological half-life of ^{137}Cs among fish that were close to equilibrium with ^{137}Cs and fish that received a single feeding of ^{137}Cs. The short component of the bio-

logical half-life of ^{137}Cs was 8 days and the long component 190 days at 15 C. The biological half-life of potassium consisted of only one component which was 40 days at 15 C. The assimilation of ^{137}Cs increased with fish size and it varied for different types of food from 3% to 70%. The assimilation of potassium was almost complete for all types of food. The intakes of ^{137}Cs, stable cesium, and potassium in bluegill were calculated for a non-equilibrium state considering the growth of the fish, the seasonal cycling of the concentration and the excretion rates. Feeding rates were calculated on the basis of the daily ^{137}Cs intake, the concentration of ^{137}Cs in bluegill's food, and the assimilation percentage of ^{137}Cs for different food items. The feeding rate of bluegill was in a positive relationship with the temperature of water, but the correlation was not complete. The daily meal was at a minimum, 0.8% of body weight, in February increasing rapidly during May to a maximum, 3.2% in June whereafter it decreased gradually towards the winter. The annual mean of daily meal was 1.75% of body weight. The annual mean of the feeding rates of bluegill calculated on the basis of stable cesium and potassium balances agreed well with the mean of feeding rates calculated by the ^{137}Cs balance. The concentration of ^{137}Cs was highest in golden shiner and lowest in redear sunfish while the concentration of stable cesium was highest in goldfish and lowest in bluegill. The concentration of potassium varied only slightly among different species of fish. There were no consistent relationships between ^{137}Cs, stable cesium, and potassium concentrations in different species of fish in White Oak Lake. The specific activity of ^{137}Cs in different fish species varied from one to two and a half times that of water. (auth)

5979 ION SCAVENGING BY THE EASTERN CLAM AND QUAHOG. Andrews, Howard L.; Warren, Shields (Sea Farm Research Foundation, Waltham, Mass.). Health Phys.; 17: 807-10(Dec 1969).

The depletion of ^{131}I, ^{85}Sr, and ^{59}Fe from seawater by the clam and quahog and the fecal excretion of these elements was determined. The concentration of these elements in the feces was found to be increased by several orders of magnitude over that in the seawater. This may be an important factor in the transfer of nuclides to bottom sediments. (auth) (UK)

5980 DETOXIFICATION OF PESTICIDAL RESIDUES IN FISH AND SHELLFISH. Hallab, Abdul Hamid. Baton Rouge, La., Louisiana State Univ. Baton Rouge, La., Agricultural and Mechanical Coll., 1968. 94p.

Thesis.

Studies were carried out on oysters and shrimp to determine detoxification agents in vivo and in vitro that will lessen or minimize toxicity of chlorinated pesticides. Sublethal doses of endrin, dieldrin, p,p′-DDT, and toxaphene were established. In shrimp the sublethal dose for endrin was found to be between 0.00175 and 0.02675 ppM, that of p,p′-DDT was found to be between 0.025 and 0.075 ppM. Dieldrin sublethal dose was found at 0.1 ppM and toxaphene was at 1 ppM. Mortality rates indicated clearly that endrin is the chlorinated pesticide most toxic to fish and shellfish followed by p,p′-DDT, dieldrin, and toxaphene in that order of toxicity. Ability of oysters to concentrate certain pesticides from surrounding environments was demonstrated. Oysters concentrated 180% of original endrin applied and 200% of original p,p′-DDT applied. Aminopyrine, orinase, and pyralgin were used in 1 and 10 ppM concentrations as detoxification agents. They were applied to the experimental animals with sublethal doses of chlorinated pesticides. Results indicated that of the three detoxification agents investigated, orinase at 1 and 10 ppM showed most promise in degrading pesticides in oysters and shrimp. In the in vitro studies oysters spiked with 0.1 to 2 ppM of chlorinated pesticides were irradiated at different levels of irradiation with ^{60}Co, x-ray and ultraviolet rays. The results showed that x-ray irradiation was ineffective in degrading the pesticide molecule. ^{60}Co irradiation showed highly significant effects ($P < 0.01$) in degrading the pesticide molecule at 0.2 and 1.0 MRAD. Ultraviolet light irradiation showed highly significant ($P < 0.01$) effect in the degradation of endrin and dieldrin. A linear and inverse relationship was found between time of exposure and rate of degradation of endrin and dieldrin when irradiated with uv light. (Diss. Abstr.)

5981 THE INFLUENCE OF STABLE IODINE ON THE VALUE OF ABSORBED DOSES IN THE THYROID GLAND IN MULTIPLE INTRODUCTION OF RADIOIODINE. Arkhangelskaya, G. V.; Ilin, L. A.; Likhtarev, I. A. (Leningrad Research Inst. of Radiation Protection). Med. Radiol.; 14: No. 10, 19-21 (Oct 1969). (In Russian).

It is shown that in multiple introduction of ^{131}I into rats a significant effect of absorbed doses in the thyroid gland could be achieved only by way of numerous administrations of relatively large quantities of stable iodine. The single administration of large doses with subsequent administration of small doses of the preparation yields a lesser effect, however it is greater than a rare introduction of large quantities. The results derived may be explained in the light of modern concepts on the kinetics of iodine in the organism. (auth)

5982 THE DISAPPEARANCE OF ^{133}Xe AND ^{125}I IN THE CANINE GASTROCNEMIUS MUSCLE FOLLOWING VASOCONSTRICTION AND VASODILATATION. Bolme, P.; Edwall, L. (Karolinska Institutet, Stockholm). Acta Physiol. Scand., 76: 8A-9(May-June 1969).

Changes in the blood flow were compared with changes in disappearance rate of a lipid-soluble (^{133}Xe) and a water-soluble (^{125}I) radioisotope during vasoconstriction and during different types of vasodilatation. A recent study showed that changes in disappearance rate sometimes appreciably deviated from the recorded blood flow changes. The disappearance of ^{133}Xe and ^{125}I was followed in the isolated gastrocnemius muscle of anesthetized dogs by an external detector. During vasoconstriction, blood flow and disappearance rate were decreased to the same extent, resulting in a disappearance-flow ratio of ~1, regardless of whether ^{133}Xe or ^{125}I was used. During metabolic vasodilatation the disappearance-flow ratio usually exceeded 1 (range 0.3 to 11). This was observed during the whole period of vasodilatation. In some experiments the blood flow was kept constant at resting level during motor nerve stimulation. An increase in the disappearance rate was then regularly observed. The results were about the same whether ^{133}Xe or ^{125}I were used. Effects of acetylcholine differed from those observed during metabolic vasodilatation. Thus, the initial effects on disappearance-flow ratio were less. Furthermore, in late phases of acetylcholine infusion the disappearance rate approached control levels in spite of a continued high blood flow. The observed differences between metabolic and acetylcholine-induced vasodilatations were most prominent with ^{125}I. Differences observed between the two types of vasodilatation were probably due to different effects exerted by them on the exchange surface area. Evidently, the disappearance of hydrophilic tracers is dependent on the available surface area. Even for lipophilic solutes the disappearance is influenced by changes in the available surface area during vasodilatation. (BBB)

5983 EFFECTS OF K, Rb, DIAMOX, AND ALDOSTERONE ON ^{86}Rb RETENTION IN THE RAT. Chertok, Robert J.; Lake, Suzanne; Hitchman, Jack W. (Univ. of California, Livermore). Contract W-7405-eng-48, Health Phys., 15: 519-26(1968). (UCRL-70641).

Potassium, rubidium, Diamox, and aldosterone were reported to have direct effects on the renal excretion of potassium. Their effects on the retention and distribution of rubidium were therefore studied by whole-body counting of rats intraperitoneally injected 24 hr earlier with ^{86}Rb Cl. The treatments were begun after the initial counting. After the rates of loss of ^{86}Rb were established, the organs were removed and counted with a scintillation counter. The ^{86}Rb initially injected in the control animals was reduced to 50% in 9.5 days. In the animals that received 100 mM KCl or 100 mM RbCl in the drinking water, or 30 mg Diamox or 30 μg d-aldosterone injected intraperitoneally daily, the initial amounts of ^{86}Rb were reduced to 50% in 5.2, 5.6, 7.4 and 8.8 days, respectively. The liver and spleen contained the most ^{86}Rb on a wet weight basis. Distribution of ^{86}Rb was altered only in those rats receiving RbCl as a treatment. The brain and muscle appeared to contain more ^{86}Rb while the liver contained less than the controls. (auth)

5984 EFFECTS OF DEUTERIUM REPLACEMENT ON SEED DEVELOPMENT: INFLUENCE ON EXCISED EMBRYOS. Crane, F. A. (Univ. of Illinois, Chicago); Blake, M. I.; Uphaus, R. A.; Katz, J. J. Can. J. Bot.; 47: 1465-7(Sep 1969).

The effects of heavy water on the elongation of excised embryos of several seed species are noted. Under autotrophic conditions, increase in embryo size is small. Added sucrose ameliorates the repressive effects of deuterium on growth. This study shows that the species-specific effects of deuterium are separable from the environmental effects. (Canada)

5985 ENDOCYTOSIS IN THE URETERIC DUCT EPITHELIUM OF THE HAGFISH (MYXINE GLUTINOSA L.). Ericsson, Jan L. E.; Seljelid, Rolf (Karolinska Institutet Medical School, Stockholm). Z. Zellforsch. Mikroskop. Anat., 90: 263-72(1968).

Uptake of ThO_2 and ferritin particles by ureteric duct epithelium, which has a specialized absorptive function in the hagfish, was studied. Thorotrast, 0.25 to 2.5 μl, was injected into the ureteric duct. By electron microscopy Thorotrast particles with easily identifiable fine structure were found in the lumen of the ureteric duct, either free or adhering to the apical plasma membrane, particularly on the microvilli. The ThO_2 particles were also present

in bristle-coated pits and tubular invaginations of the plasma membrane, as well as in coated and uncoated apical vesicles and vacuoles. Coated apical vesicles were usually located closer to the apical plasma membrane than the uncoated ones. The Thorotrast particles tended to be located peripherally in the vesicles and vacuoles and often appeared to be in contact with the submembrane coatings. Particles of ThO_2 lying free in the cytoplasmic ground substance were rarely observed. No Thorotrast was seen in the cytosomes. Unlike Thorotrast, ferritin molecules did not appear to be associated with the luminal membrane coatings in apical vesicles and vacuoles. The findings indicate that Thorotrast and ferritin particles are absorbed by the ureteric duct cells by way of endocytosis. With Thorotrast, the first step in the uptake phase appears to be the attachment of Thorotrast particles to the surface coating on the apical plasma membrane. (BBB)

5986 DISTRIBUTION OF RADIOACTIVE ARSENIC IN SEVERAL TISSUES. Novak, L.; Knajfl, J.; Smid, A. Cesk. Stomatol., 69: 95-103(Mar. 1969). (In Czech).

Following deposition of ^{76}As in teeth of dogs, the distribution in local and distant tissues was studied. A scintillation counter was used for measuring activity of tissue samples. Results showed little damage to periapical tissues, and amounts observed in other tissues were of no toxicological importance. (auth)

5987 THE INFLUENCE OF CHOLINERGIC DRUGS ON ^{86}Rb EFFLUX IN ISOLATED ATRIAL TISSUE. van Zwieten, P. A. (Christian-Albrechts Univ., Kiel). Eur. J. Pharmacol., 5: 49-55 (Dec. 1968-Jan. 1969).

Guinea pig atria were suspended in a Tyrode solution that contained 2.7 mMol Rb^+ instead of the equivalent concentration of K^+ (Rb-Tyrode solution) and were loaded with ^{86}Rb in a Rb-Tyrode solution containing at least 3 μCi ^{86}Rb/ml for 2 hr at 30°C. The influence of cholinomimetric drugs on the release of accumulated $^{86}Rb^+$ ions was studied. In Rb-Tyrode medium the atria showed entirely normal mechanical behavior. Both acetylcholine and carbachol caused a pronounced, dose-dependent acceleration of ^{86}Rb release in electrically driven atria. The effect was blocked by atropine. High doses of acetylcholine and carbachol in the presence of atropine caused a positive inotropic effect, accompanied by an increased rate of ^{86}Rb release. Both effects were probably brought about by the mobilization of endogenous noradrenaline, since they were completely abolished in reserpinized animals. Diisopropylfluorophosphate (DFP) showed a negative chronotropic and inotropic action only in spontaneously beating atria. The effect was accompanied by an accelerated release of ^{86}Rb. However, DFP in high doses neither affected the mechanical activity nor the rate of ^{86}Rb release in electrically driven atria (frequency 180/min). This observation might be explained by the depletion of acetylcholine of the atrial tissue as a result of electrical stimulation. It was concluded that cholinomimetic drugs increase the rate of ^{86}Rb release. (BBB)

5988 RESEARCH OF A TUMOR-SPECIFIC LOCALIZING AGENT FOR RADIOISOTOPE IMAGE: THE SYNTHESIS OF 5-IODOURACIL-^{131}I AND ITS DISTRIBUTION IN TUMOR BEARING MICE. Maeda, Tatsuo; Matsuoka, Junnosuke; Ishibashi, Tatsuto; Kojima, Masaharu; Kono, Akira; Tsumori, Akiko (Kyushu Univ., Fukuoka). Radioisotopes (Tokyo), 18: 212-15 (June 1969). (In Japanese).

5-Iodouracil-^{131}I (5-^{131}IU) was synthesized and its distribution in tissues of mice was investigated. The results were as follows: The synthesis was performed in newly devised glass apparatus to reduce the γ-ray exposure during the chemical procedure. The thin layer radiochromatogram indicated that the iodination was completed in one hour after reaction mixture. Specific activity of 5-^{131}IU was 1 mCi/mg (600 μCi/ml), and the yield of 5-^{131}IU was 60%. The autoradiolysis was 10% in 30 days. The stomach and kidney had a special affinity for 5-^{131}IU, and the tumor implanted in mice (Ehrlich tumor) incorporated in relatively high ratio in 1.5 to 2.0 hr after intraperitoneal injection. But the microautoradiographic study showed no evidence of incorporation of 5-^{131}IU in tumor cells. The thin layer radiochromatogram revealed that the radioactive substance in gastric tissue (1.5 hr after injection) was no longer in the form of 5-^{131}IU. (auth)

5989 ALTERATION OF THE VOLUME OF THE VASCULAR CHANNEL OF THE KIDNEYS IN ^{210}Po AFFECTION. Astapova, S. A. Med. Radiol., 14: No. 9, 69-71(Sept. 1969). (In Russian).

Experiments involving the filling of vessels by a mixture of india ink and gelatin following chronic radiation damage by ^{210}Po (0.005 mμ Ci/G), showed that in kidneys there occurred a decrease in the volume of the vascular bed. The capillary net of the glomerulose and stroma, arterioles and microarteries are subjected to deterioration and cessation of blood circulation. The most injurable components are the glomerular capillaries. Up to 50 to 75% of the glomerular capillaries and up to 50% of the stroma capillaries are closed to blood circulation following chronic ^{210}Po damages. (tr-auth)

5990 INTERNAL DISTRIBUTION AND MILK SECRETION OF ^{210}Po AFTER ORAL ADMINISTRATION TO A LACTATING GOAT. Schreckhise, R. Gene; Watters, Robert L. (Colorado State Univ., Fort Collins). J. Dairy Sci., 52: 1867-9(Nov. 1969).

The distribution of ^{210}Po in a lactating goat after a single acute oral administration of $^{210}PoO_2$ was studied. The transfer coefficient (per cent intake per liter of milk) was estimated to be 0.18. This was much higher than the 0.029 reported earlier for $PoCl_4$ in a lactating cow. The concentrations in the organs and selected tissues at 20 days post-ingestion are reported. Highest concentrations in decreasing order were found in hair, kidney, bile, and liver. This experiment was a pilot study for evaluating the hazard which might result from the release of ^{210}Po from a radioisotope electrical generator designed for space missions. (auth)

5991 INCORPORATION OF RADIOACTIVE LABEL FROM PYRIMIDINES INTO LIVER LIPIDS. Myers, D. K.; Ram, S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Physiol. Pharmacol.; 47: 731-3(Aug 1969). (AECL-3345).

After injection of tritiated thymidine into rats, the lipid fraction of the liver contained three times more tritium than did the nucleic acid fraction. Similar results were obtained with labelled thymine, uracil, and cytosine. The results emphasize the importance of exhaustive lipid extraction in autoradiographic studies of nucleic acid synthesis. (auth) (Canada)

Radiation Effects

Refer also to abstracts 5682, 6035, 6054, 6063, 6157, 6160, 6161, and 6162.

5992 (N-68-32427) RADIATION EFFECTS ON THE METABOLISM OF PHOSPHOLIPIDS IN THE CENTRAL NERVOUS SYSTEM OF ALBINO RATS: EFFECTS OF X RAYS ON SPINGOMYELIN BIOSYNTHESIS IN BRAIN AND SPINE MITOCHONDRIA OF ALBINO RATS. Progress Report, July 1, 1967-August 31, 1968. Lee, Charlotte O. (Alabama A and M Coll., Normal). 43p. (NASA-CR-96228; PR-5). CFSTI.

The effect of x rays on the biosynthesis of phospholipid and sphingomyelin in brain and spinal cord mitochondria of rats was studied. Mitochondria were isolated from male rats, irradiated and incubated with precursors of sphingomyelin. Sphingomyelin was isolated from the reaction mixture as alkali stable phospholipid. Identification of sphingomyelin was accomplished by infrared spectra, thin layer chromatography, and phosphorus determinations. Spinal cord mitochondria appeared to be the best source of ceramide transferase for sphingomyelin synthesis. X irradiation caused an increase in sphingomyelin from both spinal cord and brain mitochondria. Moderate doses of x rays caused a destruction of the carbonyl function of myristaldehyde. (auth) (STAR)

5993 (STI/PUB-216) ENZYMOLOGICAL ASPECTS OF FOOD IRRADIATION. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, 8-12 April 1968. (International Atomic Energy Agency, Vienna (Austria)). July 1969. 116p. (CONF-680465). IAEA $4.00. Dep.

Ten abstracts were prepared for inclusion in NSA. One additional abstract was included in the proceedings on radiation effects on enzymes involved in fruit ripening. (C.O.)

For abstracts of individual papers see: 6005-6011 and 6162-6164.

5994 RADIOLYSIS OF α-AMYLASE IN DILUTE SOLUTION. A NON-EXPONENTIAL INACTIVATION-DOSE RELATIONSHIP. Gorin, G.; Wange, S. F.; Seth, T. D. (Oklahoma State Univ., Stillwater). Int. J. Radiat. Biol.; 16: 93-7(1969).

The inactivation of α-amylase in dilute solution by cobalt-60 γ-rays was studied. It was found that the inactivation dose-relationship for α amylase in the conditions studied was neither exponential nor linear; also, this enzyme is comparatively resistant to inactivation. The enzyme was isolated from hog pancreas, dissolved in 0.05 M phosphate buffer at 0°C. It was irradiated at room temperature, 22 ± 2°C, in a gamma cell 200. The dose-rate was 4400 rads/min, determined with the Fricke dosimeter. (UK)

5995 EFFECT OF GAMMA IRRADIATION AND RADIOPROTECTORS ON ALKALINE PHOSPHATASE AND ATPase. Noaman, M.; Hamdy, M. K.; Caster, W. O. (Univ. of Georgia, Athens). Proc. Soc. Exp. Biol. Med., 129: 782-8(Dec. 1968).

Whole-body γ irradiation (750 R) affected both AP and ATPase

activities in 4 rat organs with similar changes in the period from 3 to 8 days postirradiation. However, the magnitude of these changes was different from one organ to another. Solutions of ATPase and AP (in vitro) were inactivated by irradiation. The former enzyme was radioresistant as evidenced by its D_{37} of 55 krads compared to D_{37} of 9 krads for AP. Cysteine (0.1 mM) altered the D_{37} of both AP and ATPase to 21 and 87 krads, respectively, whereas 4A1N 4-amino-1-naphthol (0.1 mM) changed the D_{37} of AP to 180 and ATPase to 138 krads. Maximum protection (20-fold) afforded by 4A1N was noted for AP. (auth)

5996 EFFECTS OF WHOLE-BODY X-IRRADIATION ON MOUSE LIVER ALPHA-HYDROXY ACID OXIDASE. Kleinbergs, S.; Bernstein, I. A. (Univ. of Michigan, Ann Arbor). Radiat. Res., 40: 213-21(Oct. 1969).

Mice were exposed to 800 R whole-body x-irradiation at a rate of 15 R per minute. Alpha-hydroxy acid oxidase activity was measured in the liver at various time intervals postexposure. The enzyme activity was increased at 24 hours postirradiation and returned to normal levels at 4 days postexposure. The intracellular distribution of alpha-hydroxy acid oxidase as determined by differential centrifugation remained unaltered after irradiation. (auth)

5997 COUNTERACTION OF PLATELET ACTIVITY AT SITES OF LASER-INDUCED ENDOTHELIAL TRAUMA. Arfors, K.-E. (Univ. Hospital, Uppsala); Hint, H. C.; Dhall, D. P.; Matheson, N. A. Brit. Med. J., 4: 430-1(Nov. 16, 1968).

A ruby laser was used to inflict precise endothelial trauma in arterioles in the rabbit ear chamber, and observations were made on the subsequent platelet activity. The effects of dextran 70 (MW 70,000; Macrodex), heparin, dipyridamole (Persantin), and prostaglandin E_1 on platelet behavior at sites of endothelial trauma were investigated. After laser endothelial trauma with an energy input of 180 to 200 J the cumulative number of platelet microemboli from the damaged site (about 6 μ in dia) in 15 min was reproducible, and therefore suitable for measuring platelet activity. Dextran 70 (2 g/Kg body weight) caused a profound reduction in platelet activity 4 to 6 hr after its administration. Heparin (12 mg/Kg body weight) had no effect. The effect of dipyridamole (2.5 mg/Kg body weight) was profound immediately after its administration, but was transient. Single intravenous injections of prostaglandin E_1 (25 and 125 μg/Kg body weight) had no effect. (BBB)

5998 EFFECT OF HIGH ENERGY IRRADIATION ON CYTOCHROME OXIDASE AND SUCCINATE DEHYDROGENASE ACTIVITIES IN RAT HEART AND BRAIN MITOCHONDRIA. Dement'eva, T. A.; Dokshina, G. A.; Pegel, V. A. (Tomsk State Univ., USSR). Vop. Med. Khim.; 15: 535-8(Sep-Oct 1969). (In Russian).

The inhibition of cytochrome oxidase and succinate dehydrogenase activities in rat liver and heart mitochondria was noted 4, 6, 24, 48, and 72 hrs after irradiation of animals with 1000 rad of γ rays with energy of 25 MeV. The inhibition of these enzymes was connected probably with the inhibition of oxidative phosphorylation and with lesions in mitochondrial structures noted after the irradiation of animals in similar conditions. (auth)

5999 QUANTITATIVE STUDIES ON THE RADIOSENSITIVITY OF SINGLE CELLS IN THE NERVOUS TISSUE. Hallen, Olle; Hamberger, Anders; Rosengren, Bengt; Roeckert, Hans (Inst. of Neurobiology, Gothenburg, Sweden). Acta Radiol., Ther., Phys., Biol.; 8: No. 1-2, 5-14(Feb-Apr 1969).

The total organic material, the RNA content, the succinoxidase activity and the potassium content of isolated Deiters' giant nerve cells were studied in rabbits after irradiation of the brain stem area. Succinoxidase activity in brain stem homogenates was also studied. The cell response is discussed in relation to other types of cell stimulation and other radiation experiments with nerve cells. The dose level for measurable effects is discussed in connection with histologic findings after delayed radiation lesions. (auth)

6000 THE EFFECT OF HIGH-DOSE X-RAY IRRADIATION ON THE FINE STRUCTURE OF THE EPIPHYSIS CEREBRI OF THE RAT. Bostelmann, Willy (Univ., Rostock, Ger.). Zentralbl. Allgem. Pathol. Pathol. Anat., 111: 78-88(1968). (In German).

In rats whose skulls were x irradiated with a single dose of 2500 R the survival times amounted to 9 days. When the pineal gland was studied at various intervals after irradiation, major histochemical changes were observed in the fine structure of the cells of the epiphysis. Initially there was hydration of the karyoplasm with disorganization of the chromosomal substance. This was followed by marked hypertrophy of the nucleus with multiple invaginations of the nuclear wall and increases and enlargement of the nucleolus. In the cytoplasm there was progressive destruction of the ergastoplasm with loss of ribosomes, great decrease in mitochondria, and a slight increase of the lysomes. There was considerable reduction in enzymatic activity. The x irradiations also produced extensive delipidization of the pineocytes, which may have been due to secretion of hormonal substances. However, there was no clear indication of the release of lipid droplets into the intercellular and pericapillary spaces. (BBB)

6001 REPAIR INCORPORATION OF PYRIMIDINE DEOXYNUCLESIDES INTO DNA OF MAMMALIAN CELLS EXPOSED TO UV LIGHT. Smets, L. A. (EURATOM-CCR, Ispra, Italy). Biophysik, 6: 85-93(1969).

Mammalian cells were exposed to ultraviolet light and the incorporation of labeled DNA precursors was studied. Irradiation caused stimulated incorporation of pyrimidine precursors in cells in which normal DNA synthesis was suppressed by hydroxyurea. This occurred also in non S-phase cells and was ascribed to a repair process of photochemical damage in DNA. Substitution of thymine bases by bromouracil promoted repair incorporation of labeled thymidine as well as deoxycytidine. A modification of current theories on the sensitizing action of bromouracil in UV irradiated cells is discussed. (auth)

6002 EPIMERIZATION OF MONOSACCHARIDES UNDER THE EFFECT OF γ IRRADIATION. THE EFFECT OF THE AGGREGATE STATE OF WATER ON THE MECHANISM OF RADIOLYSIS OF CARBOHYDRATES. Kochetkov, N. K.; Kudryashov, L. I.; Chlenov, M. A.; Livertovskaya, T. Ya. (Inst. of Organic Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 187: 332-4(July 11, 1969). (In Russian).

The irradiation of frozen aqueous solutions of ribose, arabinose, xylose, and hyxose with a concentration of 10^{-2} molar at $-78°C$ in an atmosphere of nitrogen showed that isomeric pentoses were formed by radiolysis. The radiolytic products are arabinose, xylose and hyxose from ribose. The irradiation of arabinose and xylose gave only lyxose, and the irradiation of lyxose gave arabinose. A mass-spectrometric analysis showed that the acetates of these carbohydrates had a fragmentation characteristic of pentoses. Analysis on a Cary-60 polarimeter showed that D-arabinose and L-lyxose are formed on irradiating a frozen solution of ribose. The G yield for the decomposition of ribose was 0.15 molecules per 100 eV, while the yield for the formation of arabinose was 0.01 molecules per 100 eV (on irradiating ribose). This yield for arabinose is preliminary, and probably low. Xylose and hyxose are formed at approximately the same yield as arabinose. The immobility of radical solvates leads to the formation of isomeric products, probably by capture of a hydrogen ion. This epimerization reaction is of interest as a new method of obtaining optically active isomers that are not readily available, and also as a method of investigating new types of reactions that take place in structured water. (TTT)

6003 SUCCINATE DEHYDROGENASE AND ALKALINE PHOSPHOMONOESTERASE AS INDICATORS OF THE SECRETORY ACTIVITY OF ADRENAL CORTEX. Tkacheva, G. A. (Inst. of Medical Radiology, Obninsk, USSR). Arkh. Anat., Gistol. Embriol., 54: 57-61(Jan. 1968). (In Russian).

A number of experiments were conducted on guinea pigs subjected to γ irradiation (dose of 400 R) and injection of the somatotrophic hormone. Reaction of the adrenal cortex to succinic dehydrogenase and alkaline monophosphoesterase was histochemically studied. High lability in activity of both enzymes was found. In the adrenal cortex of the control animals the somatotrophic hormone reduced lipids, intensified activity of succinic dehydrogenase and diminished that of the alkaline monophosphoesterase; these changes are considered as some indices testifying to increased function of the gland. Exposure to irradiation produced an opposite effect, i.e., storing of lipids, lowering of the succinic dehydrogenase activity and increase in the activity of the alkaline monophosphoesterase, which indicates inhibition of the secretion formation in the adrenal cortex. Reverse correlationship between the contents of lipids and that of succinic dehydrogenase and direct correlationship between the contents of alkaline monophosphoesterase and that of the sudanophil material were established. The enzymes under study may serve as reliable indicators of functional state of the adrenal cortex. (auth)

6004 EFFECTS OF X-RADIATION ON THYMIDINE INCORPORATION AND DEOXYRIBONUCLEOPROTEIN INTEGRITY IN RAT TISSUES. Myers, D. K.; Ram, S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Biochem.; 47: 1003-6(Nov 1969). (AECL-3409).

The early effect of x radiation on thymidine incorporation into deoxyribonucleic acid (DNA) did not differ markedly in rat tissues which are resistant and those which are sensitive to the lethal effects of irradiation. Inhibition of DNA synthesis was accom-

panied by loss of integrity of deoxyribonucleoprotein (DNAP) in all tissues examined during the postradiation period. The cells of radioresistant tissues were able to repair the postradiation damage to DNAP while the degradation of DNAP continued unchecked in radiosensitive tissues during a 24-hr observation period. (auth) (Canada)

6005 CHANGES IN ENZYME ACTIVITY AND PROTEIN SOLUBILITY DURING STORAGE AFTER RADIATION TREATMENT. Glew G. (Univ. of Leeds, Eng.). pp 83-90 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

The effects of electron irradiation on the enzyme alkaline phosphatase and the protein β-lactoglobulin in cow's milk was studied. The criteria of change used in this work were: activity of the enzyme in whole milk and, changes in solubility of the pure protein that occurred as a result of radiation treatment. It was found that radiation after-effects occur, resulting in continuing denaturation and loss in activity after the cessation of treatment, particularly at high storage temperatures. The higher the dose rate the less was the degree of radioinduced change. More change was observed after irradiation in the presence of oxygen than in its absence and this effect was dose-rate dependent immediately after treatment but not after 8-day storage. (auth)

6006 SOME CHANGES IN ENZYMATIC ACTIVITIES OF CITRUS PEEL TISSUES AFTER FRUIT IRRADIATION. Monselise, S. P. (Hebrew Univ., Rehovoth, Israel); Riov, J.; Kahan, R. S. pp 71-81 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

Radurizing doses of ionizing radiation do not generally inactivate enzymes in situ in fruit tissues. It is also doubtful if this would be always desirable in view of the fact that fruits are living organs and must be kept viable during storage. With citrus fruit peel different cases showed changes in activity of enzymes occurring after irradiation. Peroxidase activity was generally enhanced, beginning one to two weeks after irradiation, in external peel layers. Some connection between such increase and visible damage to peel was found. The rate of increase depended on species, age of fruit, and environmental conditions. Effects of beta and gamma rays were not dissimilar. Catalase activity of external peel layers was also affected, but while it was clearly decreased in orange peel, it was enhanced, at least initially, in grapefruit peel. The above changes occurred one or more weeks after irradiation. Recently it has been shown that the activity of phenylalanine ammonia-lyase, a key enzyme in the synthesis of phenolic substances, was strongly enhanced almost immediately after irradiation. Since phenolics accumulate in damaged peel cells, it may be suggested that this is a more direct effect of radiation than the above ones, and may provide some clue to cell damage observed. (auth)

6007 PRELIMINARY STUDIES ON THE NATURE OF RADIATION INACTIVATION OF PECTIN METHYL ESTERASE AND CELLULASE PREPARATIONS. Vas, K. (Central Food Research Inst., Budapest). pp 37-45 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

Radiation resistance of a pectin methyl esterase and a cellulase preparation has been studied in the dry state and in aqueous solutions of different concentrations. The dilution effect on ^{60}Co γ radiation resistance was established with both enzyme preparations. The relative roles of direct and indirect mechanism of inactivation have been evaluated. (auth)

6008 FUNDAMENTAL ASPECTS OF ENZYME INACTIVATION BY IONIZING RADIATION. Sanner, T.; Pihl, A. (Norwegian Radium Hospital, Montebello). pp 23-36 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

The loss of activity of enzymes irradiated in the dry state may in part be due to a kind of indirect action in the sense that hydrogen atoms, electrons, and small molecular fragments formed by the absorption of energy in one molecule may interact with neighboring molecules and thereby cause chemical damage. Little is known about the nature of the chemical changes responsible for loss of activity after irradiation in the dry state. A considerable amount of work was carried out on the inactivation of enzymes in dilute aqueous solution. The OH radicals seem to be the most important water radical involved in the inactivation. The enzyme inactivation may be due to destruction of the active site, to a general denaturation, or to a combination of these factors. For most enzymes the loss of activity is associated with changes in the Michaelis Menten constant. Since in cells the substrate concentration are usually suboptimal, such effects may be of considerable importance under physiological conditions. The destruction of the active site of enzymes was most extensively studied in sulfhydryl enzymes, where destruction of sulfhydryl groups was shown to be the main mechanism of inactivation. Nevertheless, such enzymes differ in radiosensitivity by a factor of more than 10 because the sensitivity of the different sulfhydryl groups to attack of water radicals differs appreciably, and the yield of enzyme inactivation depends on the number of sulfhydryl groups that have to be destroyed before the activity is lost. The sensitivity of enzymes may be altered by factors influencing the number of the nature of the radicals available for reaction with the enzyme, by factors influencing the fate of "enzyme radicals," or the intrinsic radiosensitivity of the enzyme. The most efficient protection is achieved by the latter mechanism because in such cases the modifying agents are located at the site of action. Protection by alteration of the fate of enzyme radicals appears to be more important in the dry state than in dilute solution. (auth)

6009 INACTIVATION OF HYDROLASES IN VITRO AND IN SITU BY ^{60}Co GAMMA RAYS. Giovannozzi-Sermanni, G.; Di Marco, G.; Tomati, U. (Citta Univ., Rome). pp 15-21 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

The behavior towards the radiation inactivation of the two enzymes investigated (cathepsin C and invertase) is greatly different in vitro and in situ. The in-vitro results can be influenced by many factors, such as pH value and impurities. The influence of oxygen concentration and stage of purification have been studied. (auth)

6010 EFFECT OF GAMMA IRRADIATION ON ACTOMYOSIN SOLUTIONS. Coelho, Rose (CEN de Saclay, Gif-sur-Yvette, France). pp 1-14 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

Actomyosin solutions were irradiated by gamma rays from a ^{60}Co source. Enzymatic activities were measured in 0.6 M KCl solutions, with 1×10^{-3} M $CaCl_2$ used as an activator. In some cases the 2×10^{-4} M $MgCl_2$ inhibitor was also added to the medium. Functional properties of actomyosin were tested by turbidity measurements in 0.05 M KCl with 1.3×10^{-3} M $MgCl_2$. Irradiation leads to an increase of the enzymatic activity at low doses. This effect is particularly marked if $MgCl_2$ is added to the incubation medium. High irradiation doses result in progressive inhibition of the enzyme. The effect of gamma rays on actomyosin is of the indirect type since the dose at which maximum activation is observed decreases linearly with increasing dilution of the enzyme. Irradiation also modifies the functional properties by reducing the clearing time at low doses. Activation of the enzyme and shortening of the clear phase cannot be attributed to SH-group loss, which was measured under the same experimental conditions. Important structural modifications of the protein occur during the initial, activating phase. Very few degradation products are produced, but most of the protein becomes reticulated probably through intermolecular cross-linking. High doses result in progressive degradation at the expense of the reticulum. Degradation products of irradiated actomyosin are soluble and enzymatically inactive. High enzymatic activity is associated with the reticulated fraction. (auth)

6011 SOME EXPERIMENTS ON THE RADIOSENSITIVITY OF PROTEOLYTIC ENZYMES OF FISH TISSUES. Siebert, G.; Musch, K. (Univ. Hohenheim, Stuttgart). pp 63-9 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

A brief survey is given of proteolytic systems in fish muscle, especially in cod. High catalytic potency of cathepsins and peptidases is associated with apparently unique features of substrate specificity. Differences between maximal rates of autolytic en-

zymes and the actual appearance of autolytic products are briefly discussed. Sea-frozen cod fillet in the thawed state, a crude extract from it, and a partially purified cathepsin extract were exposed to ionizing radiation in a linear accelerator. Changes in catheptic activity were followed as a function of irradiation dose and time after irradiation. Cathepsin in cod muscle is not inactivated by doses up to 10 Mrad. The D_{37} for cathepsin in the crude extract is found at 6.2 Mrad. Partially purified cathepsin in dilute solution has a D_{37} of 0.27 Mrad. Although partially purified cathepsin solutions do not decompose after doses up to 10 Mrad, some unknown component of the crude extract becomes unstable above 0.3 Mrad. The significance of these preliminary observations in food irradiation is discussed. (auth)

Immunology

Refer also to abstracts 6122, 6148, and 6154.

6012 PROLONGED BURSAL LYMPHOCYTE DEPLETION AND SUPPRESSION OF ANTIBODY FORMATION FOLLOWING IRRADIATION OF THE BURSA OF FABRICIUS. Weber, W. T.; Weidanz, W. P. (Univ. of Pennsylvania, Philadelphia, Hahnemann Medical Coll. and Hospital, Philadelphia). J. Immunol., 103: 537-43(Sept, 1969).

Destruction of lymphoid follicles with lasting lymphocyte depletion was observed when the bursa of Fabricius of day-old chicks was exposed to 1000-R doses of x radiation on the 1st and 7th day of post-embryonic life. Irradiated bursas did not reach more than 2% of the control bursa weights over a 90-day period of observation. The numbers of germinal follicles and plasma cells were decreased in the spleens and cecal tonsils of bursa-irradiated (BI) birds. In addition, BI birds demonstrated a diminished antibody-producing capability to selected antigens, and several of them showed a transient γG dysgammaglobulinemia. No histologic differences between the thymuses of bursa-irradiated and non-irradiated birds were detected. (auth)

6013 IRRADIATION AS AN IMMUNOSUPPRESSIVE AGENT IN ORGAN TRANSPLANTATION. King, E. Richard; DeGiorgi, Lucio S.; Royster, R. Lewis; Wolf, James S.; Levitt, Seymour H. (Medical Coll. of Virginia, Richmond, Virginia Commonwealth Univ., Richmond). Radiology, 93: 297-306(Aug. 1969).

Clinical immunosuppression is attempted by total-body irradiation, local irradiation to the transplanted kidney, and extracorporeal irradiation to the circulating blood. Because of high mortality of total-body irradiation, it has been abandoned in clinical practice. Local graft irradiation has been used clinically in transplantation of the kidney, liver, and heart. It is used sequentially in the early transplant period and also during periods of accelerated rejection. Experimental data support its effectiveness as an immunosuppressive agent. Extracorporeal irradiation to the circulating blood has also been demonstrated experimentally to be an effective immunosuppressant. Its limited use in man thus far has shown that it is effective in reversing some episodes of accelerated rejection but ineffective in chronic rejection. Both of the latter methods of irradiation serve as a useful adjunct to the basic immunosuppression armamentarium of the transplant. At the Medical College of Virginia, patients receiving kidney transplants routinely receive 600 rad to the kidney during the first week post-transplant. Additional external beam irradiation is delivered if evidence of rejection occurs. (auth)

Ecology

Refer also to abstracts 5972 and 5979.

6014 EFFECTIVE HALF-TIMES OF ^{85}Sr AND ^{134}Cs FOR A CONTAMINATED PASTURE. Krieger, Herman L. (Environmental Radiation Nuclear Engineering Lab., Cincinnati); Burmann, Franz J. Health Phys.; 17: 811-24(Dec 1969).

The decrease in radionuclide concentration from a contaminated pasture, and the effect of rainfall on the removal of this deposited activity, were determined on three experimental plots (220 m^2), which were prepared by transplanting the upper 10 in. of a Wisconsin-type soil profile plus a 2 in. sod layer. In the spring of 1966, 10 mCi each of ^{85}Sr and ^{134}Cs was deposited over 140 m^2 of this area with a controlled spraying mechanism. Portions of the grass were protected from precipitation by automatically closing covers. The height of the grass in discrete plots was 2 in. or 6 in. Replicate samples from the protected plots were clipped at intervals of 1 to 8 days, while the exposed sections were sampled after each of the 20 rains during the 75-day experiment. The disappearance curves, from a statistical analysis of the activity per dry weight, showed two effective half-times. For the protected areas, the first component was approximately ten days for ^{85}Sr and fifteen days for ^{134}Cs. The second component for both tracers ranged from 25 to more than 50 days. Samples from the exposed areas were generally lower in activity after each rain. The first half-time component for ^{85}Sr and ^{134}Cs averaged 3 to 4 days, respectively, whereas the second component for the exposed area ranged from approximately 25 to more than 50 days. (auth) (UK)

6015 SIMULATION MODEL FOR AN ARCTIC FOOD CHAIN. Eberhardt, L. L.; Hanson, W. C. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 17: 793-806(Dec 1969).

A simple computer simulation model was constructed to represent the concentration of cesium-137 in a lichen-caribou-Eskimo food chain. The model incorporates exponentially decreasing fallout deposition on lichens, seasonally varying uptake of cesium-137 by caribou, and spring and fall harvests of migrating caribou by Eskimos. The various constants required in the model were independently estimated, and the outcome of the simulation was then compared with actual data on cesium-137 concentrations in caribou muscle and Eskimo body-burdens. The results of simulation runs in which constants were arbitrarily varied indicate that an improved fit (to observed data) might be obtained, but the model's principal function is considered to be analytical rather than predictive. (auth) (UK)

6016 EXTERNAL FACTORS INFLUENCING MINERALIZATION AND IMMOBILIZATION OF SOME RADIONUCLIDES FROM TREE LITTER. Witkamp, M. (Oak Ridge National Lab., Tenn.). pp 231-40 of Isotopes and Radiation in Soil Organic-Matter Studies. Vienna, International Atomic Energy Agency, 1968.

From Symposium on the Use of Isotopes and Radiation in Soil Organic-Matter Studies, Vienna, Austria. See STI/PUB-190; CONF-680725.

The kinetics of mineral elements in forest litter are being studied at Oak Ridge National Laboratory using radiotracer techniques. Special emphasis is placed on the cycling of long-lived fallout nuclides because of their potential health hazard in the food chain to animals and man. Data are being obtained from in vitro, microcosm, and field experiments and their interpretation is helped by systems analysis and analogue computer simulation of mineral flow. The results indicate that during the usual microbial bloom of newly incubated litter, loss of minerals by leaching may be reduced by as much as 50% as a result of their immobilization in microbial tissue. Only on the most rapidly decomposing litters will initial mineralization prevail over immobilization. After the bloom, release of accumulated minerals from the declining population and from the decaying substrate results in net mineralization that is proportional to the weight loss of the substrate. In general, rates of mineral turnover are positively related to concentration and availability of the nuclides, and to environmental factors that enhance microbial development (substrate, temperature, moisture). Faunal consumption of litter also enhances mineral turnover by exposing cell contents. Faunal consumption of microbial mass results in decreased immobilization of nuclides. Under favorable conditions, net and gross microbial immobilization by the microflora may amount to 22% and 61%, respectively, of the initial quantity of ^{137}Cs in the litter. Leaching (excess rain) releases only a few per cent of the immobilized nuclides but freezing, drying, and burning may result in almost complete release. Much of the re-mineralized nuclide is immediately re-adsorbed by the substrate, in particular by charred leaves. Burning also releases minerals to the atmosphere in smoke or by volatilization. In field experiments on the forest floor, rates of mineral turnover vary greatly in time as a result of changes in weather conditions. Consequently periods of net immobilization in the forest are short and the average per cent net immobilization is lower than that found in the laboratory. Thus, even though the microbial and faunal compartments are relatively small as compared with other litter compartments, their role in mineral kinetics is appreciable because of high rates of turnover. (auth)

6017 RETENTION OF A FALLOUT SIMULANT CONTAINING ^{134}Cs BY PINE AND OAK TREES. Witherspoon, J. P.; Taylor, F. G. Jr. (Oak Ridge National Lab., Tenn.). Health Phys.; 17: 825-9(Dec 1969).

Small white pine (Pinus strobus) and red oak (Quercus rubra) trees were contaminated in the field with a fallout simulant consisting of 88 to 175 μ dia. quartz particles containing ^{134}Cs. Whole plants were harvested at intervals up to 33 days after application of the simulant, and the ^{134}Cs retention by each species was determined. The initial fraction of the simulant retained by foliage was higher in the oaks (0.35) than in the pines (0.24). However, after one hr, the broad leaved oaks had lost 90.5% of the initial ^{134}Cs concentrations while the pines had lost only about 10%. These early

retention differences are related to the effects of wind on the two distinct foliage types. Effective half-lives were calculated for both species at intervals of 0 to 1 day, 1 to 7 days and 7 to 33 days. For pine trees these values were 0.25, 4.53 and 20.66 days, respectively. For oaks they were 0.12, 1.41 and 24.86 days. Loss of particles (^{134}Cs) was due, primarily, to the weathering action of wind and rain during the study. The effects of wind and the first rain following contamination accounted for a large percentage of the total radionuclide loss during the study. (auth) (UK)

6018 THE RADIOACTIVITY OF GRAIN: LEGUMINOUS PLANTS. Muminov, M. M.; Maksudov, U. Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 75-7(1969). (In Russian).

The beta and gamma radioactivity of cereal and leguminous plants was investigated. The activity in leguminous plants was several times greater than that in cereal plants. Calcium-48 and ^{40}K were identified as sources of the natural radioactivity. (M.C.G.)

6019 LOSS OF WEIGHT, ^{60}Co, AND ^{137}Cs FROM TREE LITTER IN THREE SUBSYSTEMS OF A WATERSHED. Witkamp, Martin; Frank, Marilyn L. (Oak Ridge National Lab., Tenn.). Environ. Sci. Technol., 3: 1195-8(Nov. 1969).

Losses of weight, ^{60}Co, and ^{137}Cs from alder, sycamore, and oak leaves exposed for one year in a forest, a pond, and a brook, were exponential. Loss coefficients increased in the order: weight < ^{60}Co < ^{137}Cs at the ratio 1:1.9:4.1. For species loss, coefficients increased in the order: alder < sycamore < oak at the ratio 1:2.7:4.6. The effects of site, species, and substance were highly significant (P = 0.1%), and without significant interaction (P = 10%). Differences between weight and minerals appear to be controlled primarily by leachability, differences between species by microbial breakdown rates, and those between sites by rates of leaching and mechanical abrasion. (auth)

Genetics and Cytogenetics

Refer also to abstracts 6029 and 6116.

6020 THE EFFECTS OF RADIATION ON CHROMOSOMES OF BONE MARROW CELLS. 1. TYPE AND FREQUENCY OF RAT CHROMOSOME ABERRATIONS INDUCED BY FAST NEUTRONS, X-RAYS, AND GAMMA RAYS. Kamada, Nanao (Hiroshima Univ.). Nippon Ketsueki Gakkai Zasshi, 32: 212-35 (Apr. 1969).

Observations from three hours to 10 months after irradiation were carried out on the bone marrow cells and bone marrow chromosomes of rats exposed to 200 rads of fast neutrons, γ rays, or x rays. The bone marrow chromosome aberrations decreased rapidly after irradiation, and three days after exposure only a very small percentage of abnormal chromosomes could be seen. Chromosome changes within three days after exposure consisted mainly of such unstable chromosome abnormalities as chromatid breaks. Chromosome aberrations that occurred between one and 10 months after exposure were almost all stable chromosome abnormalities due to deletion or translocation. Clones of cells with stable chromosome aberrations were noted in five to 15% of the bone marrow cells of four rats. From the changes in bone marrow cells of irradiated rats, it was noted that chromosome aberrations which occurred shortly after exposure originated mainly from the erythroblasts. On the basis of above facts, the relationship between clones with balanced type chromosome aberrations and leukemogenic mechanism is discussed. (NSA of Japan)

6021 AN INDUCED MUTANT OF CORCHORUS OLITORIUS L. WITH ENHANCED ABSCISSION RATE. Sen, Subir (Univ. of Kalyani, Mohanpur, West Bengal, India). Ann. Bot. (London), 32: 863-6(Oct. 1968).

A mutant of Corchorus olitorius L. (cultigen, JRO-632) isolated from R_2 generation of 90 kR x-irradiated progeny was characterized by excessive leaf-fall. Although the initial rate of leaf-fall was comparable with that of the mother strain, after 65 days of growth, leaf-fall was much more rapid as revealed from comparative counts of the number of leaves and nodes. Formation of a separation layer was observed at the abscission zone of the sixth leaf above the last abscissed leaf of the mutant, whereas, in the mother strain it was initiated just above the last abscissed leaf under the same climatic conditions in the field. A crude extract from senescent leaves of the mutant accelerated separation layer formation in the abscission zone of the mother strain. The possibility of indole-3yl acetic acid repression and abscisin-like activity accelerating abscission is suggested. (auth)

6022 THE EFFECT OF IRRADIATED PLASMA ON NORMAL HUMAN CHROMOSOMES AND ITS RELEVANCE TO THE LONG-LIVED LYMPHOCYTE HYPOTHESIS. Scott, David (Univ. of California, San Francisco). Cell Tissue Kinet.; 2: 295-305 (Oct 1969).

The persistence of unstable chromosome-type aberrations in peripheral blood lymphocytes of irradiated individuals has led to the proposal that some lymphocytes survive for many years in vivo without undergoing mitosis. It was recently shown, however, that plasma from irradiated individuals can induce chromosomal damage in cultures of normal blood lymphocytes even when the plasma donors were irradiated 7 yr earlier. The present results show that a lymphocyte chromosome-breaking factor can be induced in the plasma of blood irradiated in vitro as well as in vivo. All of the aberrations induced by this plasma factor and those reported by other workers can be interpreted as being of the chromatid type. Before the long-lived lymphocyte hypothesis can be brought into serious disrepute, it must be shown that the plasma factor can induce aberrations of the same type as persist after in vivo irradiation and that these can be induced in vivo. (E.R.B.)

6023 ULTRAVIOLET-SENSITIVE MUTANTS OF CHLAMYDOMONAS REINHARDI. Rosen, Howard. Los Angeles; Univ. of California (1968). 75p.

Thesis.

Twelve mutant strains of the unicellular green alga Chlamydomonas reinhardi were isolated and found to be more sensitive than wild-type to killing by ultraviolet (uv) irradiation. Strains containing two different uv-sensitive mutations were approximately ten times more sensitive to uv light than strains carrying either uv-sensitive mutation alone, indicating that each mutation affected a different process. Nine of the mutant strains exhibited a 1:1 segregation when crossed with the wild type, thus demonstrating that each represents a single-gene chromosomal mutation. Among the remaining three mutant strains, crosses with the wild-type yielded either no viable progeny or abnormal segregation patterns with respect to uv sensitivity. The frequency of recombination between two genetic markers (pab-2 and msr) was determined from crosses homozygous for each of the single-gene mutations. A small but measurable decrease (18%) in recombination frequency was found only in crosses homozygous for one of these mutations (uvsE1). In crosses heterozygous for uvsE1 no reduction in recombination frequency was observed. Thus, a strain was recovered in which both uv sensitivity and the frequency of recombination were affected by the same gene. This may indicate that recombination and uv sensitivity have a common step. When uvsE1 and an additional uv-sensitive mutation were homozygous in a cross, the frequency of recombination was reduced to the same degree as in crosses in which only uvsE1 was homozygous. In crosses in which two uv sensitive mutations other than uvsE1 were homozygous, no effect was observed on the frequency of recombination. Preliminary experiments were performed to elucidate the nature of the defect in uv-sensitive mutants. Wild-type and uvsE1 strains of C. reinhardi were found to incorporate exogenously supplied tritium-labeled thymidine into their DNA. Both strains released radioactive label into their growth medium subsequent to irradiation with uv light, thus indicating the possible presence of a mechanism in C. reinhardi which repairs uv-induced damage to DNA. (Diss. Abstr.)

6024 FINE STRUCTURE AND COMPLEMENTATION AT THE MAROON-LIKE LOCUS OF DROSOPHILA MELANOGASTER. Finnerty, Victoria Maria. Storrs, Conn.; Univ. of Connecticut (1969). 74p.

Thesis.

Utilizing a series of deficiencies and duplications, analysis of mutations in the maroon-like (ma-1) region identified 20 cistrons in addition to ma-1. This analysis delineated precise spatial limits for the ma-1 gene and demonstrated that a deficiency for the ma-1 genetic material was not lethal. Ma-1 mutants are fully viable, but lack xanthine dehydrogenase activity, and exhibit a brownish eye color reflecting reduced drosopterins. Ma-1 mutants also lack activity for aldehyde oxidase and pyridoxal oxidase. The 19 viable ma-1 mutants used in this study were induced by x rays and a variety of chemical mutagens. Examination of the eye color of all possible heterozygotes of the viable ma-1 mutants revealed a complementation pattern consisting of 3 complons and 2 classes of non-complementary mutations. $Ma\text{-}1^{F3}$, $ma\text{-}1^{1}$, and $ma\text{-}1^{F1}$ are mutants representative of the three complons. $Ma\text{-}1^{2}$ is a double-complon mutation, complementary to $ma\text{-}1^{F3}$, but not to the other two. A group of 8 ma-1 mutations were found to be completely non-complementary. Genetic fine structure analysis was carried out using appropriately marked heteroxygous females backcrossed to tester males on standard medium enriched with purine. This chemical selective system leads to the death of ma-1 mutant progeny and survival of $ma\text{-}1^{+}$ offspring. A total sampling of approximately 5.5×10^{7} zygotes permitted recovery of 54 rare single $ma\text{-}1^{+}$ progeny. The $ma\text{-}1^{+}$ offspring fall into 2 distinct categories: one, 24 $ma\text{-}1^{+}$ recombinants exhibiting outside marker

exchange, and two, 30 ma-1$^+$ exceptionals showing no recombination for outside markers. The pattern of recombination for the outside markers exhibited by the ma-1$^+$ recombinants was used to construct a five site fine structure map, spanning approximately 1.18×10^{-3} map units. Analysis of ma-1$^+$ exceptionals demonstrates that the majority of such progeny cannot be due to reversion or to suppression, and that the exceptions are clearly associated with recombinational events. Comparison of the fine structure and complementation maps reveals that the two are co-linear. There is an asymmetric localization of non-complementary mutations reflected by a polarized pattern of complementation for such mutants. Interpretation of the functional organization of the ma-1 locus is made possible by utilizing the fine structure and complementation data in conjunction with the biochemical data of Chovnick et al. It is concluded that the phenotypic interactions in heterozygotes and the biochemical pleiotropy exhibited by ma-1 mutants, usually taken to indicate a complex genetic unit, were completely unreliable criteria for deciding whether, in fact, ma-1 is a simple or complex genetic unit. The evidence in toto permits the conclusion that the known ma-1 mutants serve to define a single cistron which exhibits intra-allelic complementation. (Disser. Abstr.)

6025 EFFECT OF ALPHA-IRRADIATION ON CHLORELLA SURVIVAL AND MUTATION. Vekshina, L. K.; Kogan, I. G.; Kudryashov, E. I.; Pyatyshev, D. R.; Sakovich, I. S.; Shevchenko, V. A. Kosm. Biol. Med.; 3: No. 5, 34-8(Sep-Oct 1969). (In Russian).

Owing to the small size of its cells, Chlorella is a suitable model for studying the effect of dense ionizing radiation on the living organism. The experiments revealed an exponential relationship between Chlorella survival and dosage of alpha-irradiation, a stimulatory effect of low doses of irradiation upon cellular division, and changes in Chlorella mutability depending on irradiation doses. (auth)

6026 QUANTITATIVE EVALUATION OF BONE MARROW INJURIES IN LOCAL IRRADIATION. Yarmonenko, S. P.; Redkina, E. K.; Shapiro, I. M.; Bigalieva, R. K.; Golub, S. A.; Zhurbitskaya, V. A.; Raeva, I. I. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol.; 14: No. 10, 25-31(Oct 1969). (In Russian).

Cytokaryological investigations were made of the degree of radiation injury of the bone marrow in patients with tumors situated in the thoracic cavity (cancer of the lungs and esophagus) after local x irradiation. There was found a linear relation between changes of the number of cells with chromosomal aberrations and the irradiation dose within the range of 0 to 500 rad. In model experiments on mice-hybrids F(CBAxC$_{57}$BL) it was shown that under the influence of mexamine the number of cells with radioinduced chromosome aberrations has a similar reduction in the irradiated bone marrow in total and local irradiation. Between changes of the number of injured bone marrow cells and the percentage of lethality in animals in different doses of irradiation there exists a strict correlation, thanks to which the respective dependence is described by one curve. Cytokaryological investigation of the bone marrow is recommended as a means of quantitative assessment of radiation injury of the organism and the degree of effectiveness of antiradiation measures. (auth)

6027 STUDIES ON THE INDUCTION OF MUTATION BY MEANS OF RADIATION AND CHEMICALS. III. CLASSIFICATION OF MUTANTS BASED ON AGRONOMIC CHARACTERISTICS. Harn, C.; Kim, C. M.; Im, K. H.; Kim, Y. S. (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul), 9: No. 1, 67-72(1969). (In Korean).

Two rice varities, Chugoku No. 31 and Palkeum, were x irradiated and 150 and 135 mutant strains were observed in the R_2 generation, respectively. These mutant strains were analyzed for agronomic characteristics. The results obtained were as follows: Two varieties showed high frequency in the mutants of heading date, Chugoku No. 31 being 38% and Palkeum 59%. Other characters showed almost as much mutation rate. There occurred frequently changes in more than two traits in individual mutant strains. Culm height tended to mutate to short-culm. The number of panicles showed wide range of variation, the number tending to increase in two varieties. Grain number per panicle increased in Chugoku No. 31 but decreased in Palkeum. As for heading date early maturity was 90% in Chugoku No. 31, while in Palkeum late maturity was up to 94%. (auth)

6028 INDUCTION OF BACTERIUM PARACOLI 5099 MUTANTS WITH MODIFIED DNA COMPOSITION BY ULTRAVIOLET RADIATION. Gauze, G. F.; Dudnik, Yu. V.; Laiko, A. V.; Netyksa, E. M. (Inst. for the Search for New Antibiotics, Moscow). Microbiology (USSR) (Engl. Transl.), 37: 580-2(July-Aug. 1968).

Bacterium paracoli strain 5099 constitutes a suitable system for the induction of mutants with DNA of modified nucleotide composition. Using this model, the relation between the occurrence of mutants with a modified DNA nucleotide composition and the radiation dose was examined. As the source of uv (2540 Å), a lamp giving a radiation intensity of 11.54 erg/cm^2 at a distance of 33 cm from the radiation source was used. The percentage of guanine-cytosine (G-C) pairs in DNA of the initial strain B. paracoli 5099 and 50 mutants with small, yellow, trypaflavine-sensitive colonies, induced by uv radiation, was determined. In all the mutants the content of G-C pairs in the DNA increased to 67 to 71%, as compared with 48% in the parent culture. A study of antigenic interrelations showed the existence of cross-agglutination between the parental strain and the mutants. The relation between the frequency of induction of mutants with DNA of modified nucleotide composition (in 10^3 surviving cells) and the uv dose, is shown. This frequency depended on the dose and attained a maximum at 860 erg/mm^2. Mutant induction decreased above or below this maximum; at exposures less than 350 erg/mm^2 or greater than 1900 erg/mm^2, no mutants with modified DNA composition appeared. The fate of the kanamycin-resistance marker in mutants with DNA of modified nucleotide composition was studied. Kanamycin resistance was lost in all 13 mutants with DNA of modified nucleotide composition, derived from the initial resistant strain. The minimal inhibitory concentration of kanamycin for the mutants was only 5 μg/ml. Kanamycin resistance is caused by a decrease in the permeability of the cell membrane for the antibiotic. Therefore, mutants with DNA of modified nucleotide composition had lost the reduced permeability with respect to kanamycin typical of resistant cells. Mutants with DNA of modified nucleotide composition could also be induced by treating B. paracoli 5099 with 5-fluorouracil. The content of G-C pairs in the DNA of 5-fluorouracil-induced mutants was similar to that for uv-induced mutants. The rate of oxidative processes in the mutants was more refractory to the stimulatory effect of glucose and increased by a factor of only 1.4 to 2.6; in the initial strain, under similar conditions, oxidation increased by a factor of 5.3. (BBB)

Health Physics and Safety

Refer also to abstracts 5708, 5825, 5826, 5860, and 5934.

6029 ABSTRACTS OF PAPERS FOR THE SIXTEENTH ANNUAL MEETING OF THE RADIATION RESEARCH SOCIETY, HOUSTON, TEXAS, APRIL 21-25, 1968. New York, Academic Press Inc., 1968. 106p. (CONF-680421-(Abst.)).

Abstracts of the papers presented at the sixteenth annual meeting of the Radiation Research Society are presented. The society met in Houston, Texas during April 21 to 25, 1968. An author index to the papers is included. For abstracts of individual papers see CONF-680421. (E.R.B.)

Radioactive Contamination and Decontamination

Refer also to abstracts 5979, 6014, 6015, and 6017.

6030 TRITIUM CONCENTRATIONS IN NEUTRON GENERATOR PUMP OIL. Watson, E. E.; Cloutier, R. J.; Berger, J. D. (Oak Ridge Associated Universities, Tenn.). Health Phys., 17: 739-40(Nov. 1969).

Forty-two samples of fore-pump oil from neutron generator facilities in the United States and Canada were analyzed for tritium. Although results do not settle the question of how serious the risk from tritium in oil may be to anyone who opens and services generator fore pumps, sufficient tritium is present in the oil to cause considerable contamination. (UK)

6031 METHODS OF ESTIMATING POTENTIAL DOSE EQUIVALENTS TO POPULATION GROUPS. Cowser, K. E.; Struxness, E. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 814-15(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6032 ENGINEERS' GUIDE TO THE ELEMENTARY BEHAVIOR OF RADON DAUGHTERS. Evans, Robley D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-952. Health Phys., 17: 229-52(Aug. 1969).

Graphs and tables are provided for the growth and decay of the "daughter products" of radon (RaA, RaB, RaC, and RaC') whose interrelationships dictate many engineering requirements in underground uranium mining. The "working level" (WL) unit of radon daughter product concentration and α-radiation exposure rate is defined and is shown to depend strongly on the airborne concentration of RaB, even though RaB emits no α-radiation. In air which initially contains radon but none of its decay products the daughter

product WL increases during the first 40 min approximately as the 0.85 power of time. If the air contains 2 or more radionuclides, say RaA and RaB, at equal concentrations then the equilibrium activities of these 2 radionuclides in the filter will not be equal, but will be in the ratio of their mean lives, which for RaB/RaA is about 9. The growth in a filter of any mixture of airborne RaA, RaB, and RaC can be represented by a systematic array of six elementary growth curves, 1 for RaA, 2 for RaB, and 3 for RaC. The radioactive decay of any mixture of RaA, RaB, and RaC can be determined without explicit mathematical formulation, using only the classical growth curves. This simplification of an otherwise complicated situation is accomplished by using the "summation rules" which connect growth and decay as complementary processes, and which view any radioactive source as a summation of independent components. The summation rules are applicable to nonequilibrium mixtures, and to activities, number of atoms, disintegration energies, components of working levels, interrupted collections, starting and stopping transients of activity in filters such as the human lung, and dilution ventilation disequilibria. (auth) (UK)

Dosimetry and Monitoring

Refer also to abstracts 5870, 5945, 6086, 6161, and 6775.

6033 (DUN-SA-115) ^{238}Pu TO POWER THE ARTIFICIAL HEART. Owen, F. E. (Douglas United Nuclear, Inc., Richland, Wash.). Sept. 23, 1969. Contract AT(45-1)-1857. 22p. (CONF-691013-1). Dep. CFSTI.

From Western Industrial Health Conference, San Francisco, Calif.

Estimates were made of the radiation dose to the patient from a ^{238}Pu-fueled artificial heart system implanted in the lower abdominal region. The heart system consists of a blood pump driven by a pulsating unit powered by the heat generated by ^{238}Pu. The advantages of using ^{238}Pu include the low shielding requirements, the long half-life, the constant heat output, and the expected service life of 10 yr or more for the unit. Medical grade ^{238}Pu suitable for use in an artificial heart implant was produced by irradiation of ^{237}Np in a production reactor. Design features of the unit are summarized. The source of the radiation dose received by the patient is 50 watts of ^{238}Pu in the fuel capsule located near the center of the cylindrical power unit. Both γ radiation and neutrons, resulting from spontaneous fission and from the bombardment of certain light elements by α particles, would be emitted from the unit. It is estimated that the intestines that surround the power unit would receive a dose estimated at 3,500 rems/yr. The natural movement of the intestines helps to reduce the radiation dose to which any segment is exposed. A spherical shape for the fuel unit serves to reduce the γ dose through self-shielding, and the addition of LiH to the other power unit material, the use of $^{238}PuO_2$ with isotopically pure ^{16}O, and the use of a Ta shield for the unit would reduce the dose rate down to 138 rem/yr. Although national and international authorities recommend limiting the radiation dose to the intestine to 15 rem/yr, it is concluded that the use of ^{238}Pu as an implantable power source for artificial hearts or heart-assist devices is feasible from the standpoint of radiological safety. (C.H.)

6034 URANIUM CASES SHOWING LONG CHEST BURDEN RETENTION: AN UPDATING. West, C. M.; Scott, L. M. (Union Carbide Nuclear Corp., Oak Ridge, Tenn.). Health Phys.; 17: 781-91(Dec 1969).

Routine uranium in vivo, urine, and fecal measurements were continued on four employees previously reported as having unusually long retention of uranium chest burdens. Data were obtained for a further period of 3½ yr. The data including this period are compared to those previously obtained, and the cases are reassessed on the basis of these additional data. It was found that the half-life of uranium in the chest, as measured by in vivo monitoring of these employees was not statistically different from that previously reported. The urine to fecal elimination rate ratio averaged about 1, indicating fecal excretion to be an important mode of lung clearance. Efforts to better determine the nature and causes of these exposures, by selection of the most likely exposure material(s), and conduction of animal inhalation experiments, are outlined. These efforts have not been successful in establishing a complete understanding of the reason(s) for the unusual retention patterns exhibited by these persons. (auth) (UK)

6035 DEOXYPYRIMIDINURIA AND LYMPHOCYTOPENIA AS INDICATORS OF ABSORBED RADIATION DOSE IN RATS. Skidmore, Wesley D.; McHale, Carolyn G. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res., 40: 124-32(Oct. 1969).

The effect of doses of mixed gamma-neutron radiations or 14-MeV neutrons on the uninary excretion of deoxypyrimidines calculated as deoxycytidine equivalent (CdR) was evaluated as a biodosimeter in rats. The rats were exposed to doses in the range from 22 to 780 rads. The excretion of CdR equivalent in the urine of irradiated rats during the 4- to 12-hour postirradiation interval was a function of dose over the range of 22–376 rads. The response was similar for the different types of radiations. In a group of 10 rats exposed to the same dose of x rays (50, 150, or 450 rads) on 3 successive days, the 4- to 12-hour postirradiation excretion of CdR equivalent was dose dependent after the initial exposure but not after the second and third exposures. The total CdR equivalent excretion after an accumulated dose of 150 to 1350 rads approximated that of an equal single dose. The disappearance of circulating lymphocytes paralleled the urinary excretion of CdR equivalent. After lymphocytes had essentially disappeared following two 450-rad doses of x rays, a third dose of 450 rads induced less excretion of CdR equivalent by irradiated rats than by unirradiated control animals. Calculations of the amount of CdR equivalent excreted per deleted circulating lymphocyte suggest that there are other radiosensitive cells that contribute to deoxypyrimidinuria. (auth)

6036 A BIOLOGICAL DOSIMETER USING MAMMALIAN CELLS IN TISSUE CULTURE AND ITS USE IN OBTAINING NEUTRON DEPTH DOSE CURVES. McNally, N. J.; Bewley, D. K. (Hammersmith Hospital, London). Brit. J. Radiol., 42: 289-94(Apr. 1969).

Ehrlich mouse ascites cells were used as a biological dosimeter to check physical methods of measurement of central axis depth doses of a beam of fast neutrons. The cells were irradiated in suspension in Perspex tubes, using air or nitrogen bubbling. Irradiations with fast neutrons under aerobic conditions were carried out at four depths in a tissue-equivalent phantom and in the absence of the phantom. The relative intensities of the radiation under these conditions agreed well with measurements using a special ionization chamber, provided allowance was made for accompanying γ radiation. The oxygen enhancement ratio was found to be 2.78 with 250 kV x rays and 1.80 with the fast neutron beam. No significant change of OER was observed for irradiations at 8.7 cm deep in the phantom. (auth)

6037 NEUTRON (15-MeV TO THERMAL) FLUX-TO-DOSE RATE CONVERSION FACTORS FOR THE STANDARD MAN. Ritts, J. J.; Solomito, E.; Stevens, P. N. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 933-4(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6038 COMPARISON OF MONTE CARLO BETA DOSE CALCULATIONS FOR POLYSTYRENE WITH EXPERIMENT. Mikhail, S. Z. (Naval Radiological Defense Lab., San Francisco); Anno, G. H.; Jordan, T. M. Trans. Amer. Nucl. Soc., 12: 935-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6039 TISSUE-EQUIVALENT KERMA VARIATION DURING AND AFTER A REACTOR EXCURSION. Leonard, B. E.; McManaman, V. L.; Lusk, J. A.; Verrelli, D. M. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Trans. Amer. Nucl. Soc., 12: 934-5(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6040 RADIOACTIVE RAW PHOSPHATE MATERIALS IN THE POLISH SEA TRANSPORT. Kotowski, S. (Medical Academy, Szczecin, Poland); Matenko, J. Rocz. Pomor. Akad. Med. Szczecinie, 14: Suppl. 2, 143-50(1968). (In Polish).

Studies were performed on samples of minerals providing the raw materials for the phosphate industry and being transloaded from vessels in Szczecin. The raw materials had arrived from Morocco, Tunis, Jordan, Egypt, and Soviet Union. The classification of the minerals was given on the basis of their pure β activity, which was estimated to be in the range of 15 to 200 pCi/g of material. As the investigated material was a powder, the natural uranium content in the samples was studied by radiometric analysis and found to be 0.005 to 0.080%. The results of the work have shown the necessity of paying attention to certain phosphate raw materials as being factors responsible for air pollution in the region of transloading. The effect that phosphate fertilizers containing trace amount of radioactive elements exert on the global radioactivity of certain useful plants was also investigated. (NSA of Poland)

6041 ASSESSMENT OF THE RESULTS OF FILM DOSIMETRY IN CZECHOSLOVAKIA. Chysky, J.; Trousil, J. Radioisotopy; 9: 697-712(Nov 1968). (In Czech).

The results of measurements of individual exposures to ionizing radiation in Czechoslovakia in 1964 and 1965, using film dosimeters, are given. More than 60% of the 3763 persons checked in 1966 had received occupational exposures of less than 100 mR. The exposure level varied according to sex, age, level of professional qualification, branch, size of workplace, and major radiation sources. In x-ray departments and at industrial gammagraphy stations the mean exposure doses were larger and high exposures were more frequent. Numerous tables and diagrams are included. (Occup. Safety and Health Abstr.)

6042 EVALUATION OF THE DIRECT AND INDIRECT TECHNIQUES OF TISSUE DOSIMETRY OF INCORPORATED ISOTOPES IN ACUTE POISONING. Shamov, V. P.; Malykhin, V. M.; Shaks, A. I. Med. Radiol., 14: No. 9, 35-8(Sept. 1969). (In Russian).

The dosimetric characteristics of ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, ^{210}Po, ^{226}Ra, and ^{239}Pu are presented, corresponding to a single uptake in the body of man. For the basic variant, corresponding to a dose load of 100 RBE in the first year, on the basis of in vitro and in vivo analysis of the dosimetric characteristics and the sensitivities of the method of radiometry of radioisotopes, the direct and indirect methods of dosimetry were estimated. The periods after poisoning, in which it was possible to use radiometry for dose calculations of the incorporated isotopes, is presented. (tr-auth)

6043 RELATIONSHIP BETWEEN THE INTEGRAL ABSORBED DOSE AND CONDITIONS OF IRRADIATION. Pospelova, I. I. (Leningrad Central Research Inst. of Roentgen-Radiology). Med. Radiol., 14: No. 9, 74-7(Sept. 1969). (In Russian).

In order to determine the relation of integral absorbed dose to the area of the functional beam and its limits, from the conditions of irradiation, experimental investigations were conducted with an apparatus that consisted of a flat-parallel chamber, tissue-equivalent phantom of organic glass, and a lamp electrometer. The chamber used consisted of 2 disc shaped plates with a diameter of 56 cm and a thickness of 1 cm. The selection of material for the walls was determined by its destination for measurement of absorbed doses in a tissue-equivalent medium. Since the phantom was constructed from organic glass, the walls of the chamber were manufactured from the same material and were the absorbing constituent of the phantom, consisting of 7 plates 30 cm in diameter and 3 cm in thickness. The investigations were conducted with an x-ray apparatus (RUM-3), a γ-apparatus (RAY-1), and the linear accelerator with an energy spectrum of radiation 4.3 MeV under the conditions of irradiation. The results of the investigation showed the following: upon irradiation of a phantom of given final dimensions with radiation with efficient energies of 80 keV, 1.25 MeV, and 1.5 MeV, the total integral absorbed doses were identical within the limits of 10%. This corresponds closely to the values for energy flow in ergs that were calculated on 1g in the given energy range. Within the limits of error of measurements the relation of total integral absorbed dose to the area of the field of irradiation is linear for all of the studied sources of ionizing radiation in the given range of measurement of this parameter. With an increase in area of the field of irradiation, the magnitude of the absorbed energy, calculated on 1 cm^2, is decreased. This is explained by the greater losses of energy of dispersed radiation, being dissipated by the side walls of the phantom and by the smaller fraction of absorbed energy of the initial radiation penetrating through the collimating apparatus of the source for larger fields. (tr-auth)

6044 CONTRIBUTION TO ^{90}Sr-TREATMENT OF CHILDHOOD HEMANGIOMAS. Glaser, F. H. (Martin-Luther Univ., Halle, Ger.). Kinderaerztl. Prax., 36: 12-20(Jan. 1968). (In German).

Up to a depth of 5 mm, hemangiomas in infants are best treated by strontium-90 applicators instead of x radiation or gamma radiation. Unsurpassed is the limitation of the radiation field to a special area, a lack of radiation hazards to surroundings and to gonads of both patient and hospital personnel. From plastic material with suitable apertures protective shielding can be easily adapted to a given tumor. Fractionated treatment was found most useful with single doses of 100 to 300 rad and total surface doses not exceeding 1200 rad. Problems of radiation protection against characteristic x radiation originating in material of high atomic number are briefly discussed. (H.B.G.)

6045 MICROTHERMOLUMINESCENT DOSIMETER FOR DETERMINING ^{131}I AND ^{132}I DOSE ABSORPTION BY THYROID. Peter, Ferenc; Osvay, Margit; Kertesz, Laszlo. ATOMKI (At. Kut. Intez.) Kozlem.; 11: 43-6(Oct 1969). (In Hungarian).

Iodine isotopes have been used in thyroid diagnostics for decades but the determination of the actually absorbed dose by the thyroid and surrounding tissues was estimated almost exclusively by calculations. Microthermoluminescent dosimeters were made by filling glass capillaries with tissue-equivalent LiF powder in order to determine the irradiation dose from ^{131}I and ^{132}I isotopes in the thyroid. Measurements were made inside of a glass thyroid model, on the outer wall of it, and on the outer side of a neck phantom made of tissue-equivalent medium in which the glass thyroid model was placed. It was found that under these conditions ^{132}I isotope gives a dose for the thyroid about eight times less than the dose given by ^{131}I. Considering the biological half-life of the two isotopes the human application of ^{132}I is more favorable. (auth)

Radiation Protection

6046 (AD-691454) MONTE CARLO STUDY OF INTERIOR PARTITION EFFECTS ON FALLOUT SHIELDING. Final Report. Price, J. H.; French, R. L. (Radiation Research Associates, Inc., Fort Worth, Tex.). 15 Jan 1969. Contract N00228-68-C-1770. 66p. (RRA-T-91; USNRDL-TRC-69-5). CFSTI.

Protection factors were calculated by Monte Carlo for cylindrical barriers with a concentric interior partition. The barrier thicknesses were 20, 40, and 80 psf and the partition thicknesses were 20 and 40 psf. The radius of the barrier was 10.0 ft and the interior partition had radii of 2.5, 5.0, and 10.0 ft. The cylindrical concrete barriers were infinite in height. The Engineering Method was also used to calculate protection factors for the cylindrical barriers, and the results were compared with the Monte Carlo data. (auth) (CFSTI)

6047 ELEVEN RECOMMENDATIONS OF RADIOGRAPHIC EXAMINATION IN ORAL DIAGNOSIS. N. Y. J. Dent., 38: 101 (Mar. 1968).

Recommendations are made to dentists for reducing x-ray exposure in radiography. Radiographic examinations should not be made periodically or be a standard part of every dental examination. Use the fastest speed film available (USASI Speed Group rating of "D" or faster). Use only a collimated x-ray machine so that the circular beam striking the skin is not more than 2.75 in. in diameter. The x-ray machine should contain filtration of 2 mm of aluminum equivalent if operating at less than 70 KVp and 2.5 mm of aluminum equivalent if operating at 70 KVp or above. Use shielded open-end cones to reduce scatter radiation. Use lead aprons on children and all patients in the reproductive age range as a further precaution to prevent radiation of the gonads. Use film holders, bite tabs, or other means to position film during exposure. The dentist or assistant should never hold a film in place for a patient. Have periodic radiation protection surveys made of the office. The x-ray film should be properly exposed; overexposure with underdevelopment subjects the patient and office personnel to unnecessary irradiation. Follow manufacturer's instructions for processing x-ray film. (BBB)

6048 RADIATION PROBLEMS IN ROENTGEN EXAMINATIONS OF THE CHEST. Fendel, H. (Univ., Tuebingen, Ger.). Progr. Pediat. Radiol., 1: 18-32(1967).

Radiation protection in pediatric thoracic radiography and fluoroscopy is surveyed. In a pediatric x-ray department, patients of the younger age groups predominate. Therefore, in considerations of radiation problems and measures appropriate to reducing patient doses, special conditions relating to infants and younger children play the major role. Chest studies are, in general, the most frequent single type of x-ray examinations. In radiographing infants and younger children, the author prefers high-definition intensifier screens, and in children over 2 yr the faster universal screens. For a single chest film the dose amounts to 2 R × cm^2 in infants and 20 R × cm^2 in young adults. One roentgenologic investigation by chest films in 2 projections requires about 8 R × cm^2 in infants and in adolescents about 50 R × cm^2; that is, about 4 times that required for a plain sagittal film. Comparison of the doses in conventional and hard-ray technique (120 kVp) showed no significant differences. Ten yr ago, routine chest fluoroscopies constituted about 45% of all roentgenologic applications; today their share amounts to only 0.27%. The main advantage of television fluoroscopy does not primarily consist in reducing dose but rather in the enhancement of the image quality. In spite of efforts to reduce the dose rate, the mean patient dose in chest fluoroscopy is still 3 to 4 times that required for a combined sagittal and lateral chest film. An automatic exposure control is particularly helpful in pediatric radiology, where it is difficult to estimate the exposure adequate for various body volumes. However, installation of an ionization-chamber between object and film casette attenuates (and hardens) the image-producing radiation spectrum; therefore, the ionization-chamber should be placed behind the (lead-free) film casette. Devices in hard-ray technique necessary to reduce the scattered radiation are described. (BBB)

6049 HISTOLOGICAL FINDINGS IN NORMAL TISSUE IRRADIATED UNDER THE PROTECTION OF A GRID. Otto-

lenghi, G. (Sanremo City Hospital, Italy). Minerva Radiol., 14: 277-93(July-Aug. 1969). (In Italian).

Histological findings in specimens of normal rabbit skin, testicle, liver and cartilage tissue removed from 25 hr to 40 days after soft irradiation with increasing doses (500 to 60,000 R/air) under the protection of a grid are reported, described and discussed. Evidence is produced of the effect of the grid: degeneration and repair was observed only in the "illuminated" areas of the grid in the case of superficial tissue; in deep tissue, degeneration was very slight with respect to the radiation doses employed. Comparison is made with findings reported by earlier workers and with the results of irradiation with 50% doses on unprotected tissue, specimens being taken at similar intervals. In conclusion, reference is made to earlier studies and it is shown that the grid is capable of offering biological radio-protection at least equal to that afforded by high energies on superficial tissue. (auth)

Safety Procedures

Refer also to abstracts 5829, 6030, and 6034.

6050 SCREENING PROGRAMME FOR PERSONNEL EXPOSED TO LASER RADIATION. Friedmann, A. I.; Graham, F. E. (Royal Eye Hospital, London). Ann. Occup. Hyg.; 12: 219-21(Oct 1969).

An ophthalmic screening programme is described for the examination of individuals working with lasers. No retinal damage was revealed in a group of 195 persons at risk. (auth) (UK)

6051 REAL-TIME DATA MANAGEMENT SYSTEM FOR SECURITY AND RADIOPROTECTION DATA AT C.E.N., SACLAY. Tardy-Joubert, Ph. (CEN, Saclay, France); Derrey, J.; Fiquet, P. Radioprotection, 4: 121-41(1969). (In French).

A computer system for the real-time management of security and radioprotection data at the Saclay C.E.N. is described. The electronics associated with the detectors to connect a detector to the calculator are discussed. The synchronous transmission system on a loop network is described. The general structure of the system is then considered. (J.S.R.)

6052 SAFETY OF NUCLEAR SHIPS IN HARBORS. Reade IV, John M. (Portsmouth Naval Shipyard, Va.). Trans. Amer. Nucl. Soc., 12: 423-4(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6053 SURVEY OF HIGH SCHOOLS FOR RADIATION-PRODUCING EQUIPMENT. Public Health Rep. (U.S.), 84: 520(June 1969).

A joint State–Federal survey to assess health implications in the use of radiation-producing electronic equipment in high school science classes began in April 1969 in selected schools throughout the United States. In some high schools, x-ray and other radiation equipment is being used for scientific demonstrations in an unsafe manner. The survey was conducted in 1 metropolitan area in each of the nation's 9 Public Health Service regions. About 20 high schools in each area were selected, for a national total of about 200 institutions. Electronic equipment studied for radiation hazard potential included x-ray machines, Van de Graaff accelerators, and microwave and laser devices. Preliminary reports indicated hazardous use of radiation-generating electronic equipment in high schools in several States. In one school, unshielded x-ray units were used frequently. Hand-held fluoroscopes, long recognized as dangerous, were observed in the same school. Thirty-one junior and senior high schools in another State were registered as users of radiation-producing equipment. The survey was conducted under provisions of the new Radiation Control for Health and Safety Act. (BBB)

6054 THE EXCRETION OF ADRENALINE AND NORADRENALINE IN PERSONS WORKING WITH DIFFERENT SOURCES OF IONIZING RADIATION. Kogan, I. A.; Smelchenko, L. E. (Kharkov Scientific-Research Inst. of Medical Radiology, USSR). Med. Radiol., 14: No. 9, 71-4(Sept. 1969). (In Russian).

From the results, the following facts are noted: In group 1-1, under maximum radiation limits, there was a significant reduction in the content of noradrenaline (at age 30 to 50 yr) in comparison with the control group. In groups 2-1 and 3-1 there was an increase in the secretion of adrenaline (in age 30 to 39 yr), and in group 3-1 also at 40 to 49 yr ($P < 0.05$). There was a tendency toward reduction of the content of noradrenaline in urine in all age-determined groups. In group 2-1 at age 30 to 39 yr, the secretion of noradrenaline significantly increased in comparison with group 1-1. Contrasts in the secretion of catecholamines between the groups could not be determined. On the basis of these results, it is assumed that a stimulation of the adrenal systems operating under the effects of ionizing radiation occurs, especially in groups 2-1 and 3-1. According to the results, this occurs at the largest dose of irradiation at the expense of an adrenaline link, since in all investigations the relation of adrenaline–noradrenaline is increased significantly. (tr-auth)

Civil Defense

6055 DECONTAMINATION OF STOCK FARMS. PROBLEMS OF CIVIL DEFENSE. Krugiov, V. T. Veterinariya, No. 2, 108-11(1968). (In Russian).

In case of atomic attack, radioactive dust particles must be removed not only from humans and livestock, but also from the soil, water, pasturage, buildings, fodder, and other surfaces with which humans and livestock come in contact. Such decontamination would be handled by veterinary teams. Measures taken depend on whether the atomic explosion is detonated above or on the ground, the power of the blast, the nature of the contaminated surface, the presence of proper equipment and the time available. Decontamination should begin if the radiation level rises above 0.5 R/hr. Depending on the severity of contamination, persons should wait from several hrs to several days before entering the contaminated zone, and then time spent in such zones by decontamination workers should be monitored carefully. In warm weather, roads and soil should be decontaminated to a depth of 3 to 5 cm and in winter, snow to 20 cm. Road-building, agricultural, and other structural machinery (graders, bulldozers, scrapers, plows, etc.) may be adapted to these tasks. Contaminated material should be removed as soon as possible. Asphalt surfaces should be decontaminated by heat, washing, or detergents that can be applied with street-cleaning or other spraying equipment that applies water under pressure. Buildings and routes used by animals should also be sprayed under pressure and washed with detergents. Cattleyards should be cleaned of all excrement, which should be buried at least 70 cm deep. Ceilings and ventilation equipment should be carefully cleaned and material thus collected should also be buried. Recommended detergent solution concentrations are discussed. Fodder can be cleaned and then stored until the radiation level has decreased to a safe point. Severely contaminated material must be buried. Water should be thoroughly filtered and stored in uncontaminated containers for use. Transportation equipment should be hosed down and washed with detergent and wiped with a solvent such as gasoline or benzene. Protective clothing should be worn at all times and equipment used should be redecontaminated after each day of use for two weeks or until radiation has decreased to a safe level. (JPRS) (TSS)

Medicine

Refer also to abstract 6029.

6056 RADIATION RESPONSE OF HeLa CELLS EXPOSED AT VERY LOW TEMPERATURES. Hall, D. R.; Lewis, J. D.; Town, C. D.; Fish, P. J.; Lindop, P. J. (Medical Coll. of St. Bartholomew's Hospital, London). Int. J. Radiat. Biol.; 16: 43-50(1969).

HeLa-S-3 cells have been irradiated with 14 MeV electrons in a single doses, at temperatures from 310°K down to 77°K. The best plating efficiency resulted from cooling the cells at 1°K/min in the presence of 15 percent glycerol, and then plunging into the refrigerant, and rapid thawing post-irradiation. Over the temperature range studied the D_0 of the cell survival curve increased three-fold at the change of state, i.e. the freezing point, then increased at about 0.8 rad per °K. The extrapolation number was increased three-fold at 77°K, but hypoxia did not further modify the D_0 or extrapolation number at this temperature. (auth) (UK)

6057 EFFECTS OF SINGLE AND CONTINUOUS IRRADIATION OF HeLa CELLS AT -196°C. Nias, A. H. W.; Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 16: 31-41(1969).

HeLa cells have been irradiated when frozen to liquid nitrogen temperature, and the dose-response has then been assessed in terms of survival of the colony-forming ability of cells plated out after thawing. Survival curves have been obtained after acute irradiation under various conditions and computations indicate a common extrapolation number of 3.3 for these curves. Differences in the exponential slope indicate successive dose-modifying factors when (1) the cryoprotective agent dimethyl sulphoxide is added at room temperature, (2) when the temperature is lowered to –196°C, (3) when the cells are hypoxic. This oxygen effect has been confirmed by clone-size analysis. No evidence of recovery

from sub-lethal damage was obtained from split-dose experiments in which the cells were maintained at liquid nitrogen temperature between acute doses, before being thawed and plated for survival. Cells continuously irradiated at −196°C showed the same survival values as those acutely irradiated, as well as showing a similar oxygen effect. Recovery from sub-lethal damage was not manifest immediately after the rapid thawing used in these experiments. (auth) (UK)

Protective Substances

Refer also to abstracts 5995, 6044, 6099, 6103, 6112, 6140, 6146, and 6149.

6058 COMBINED 5-FLUOROURACIL AND SUPERVOLTAGE RADIATION THERAPY OF LOCALLY UNRESECTABLE GASTROINTESTINAL CANCER. Moertel, C. G.; Childs, D. S.; Reitemeier, R. J.; Colby, M. Y.; Holbrook, M. (Mayo Clinic, Rochester, Minn.). Lancet; No. 7626, 865-7(25 Oct 1969).

A brief account is given of a controlled double blind study involving 187 patients. The results suggested that 5-fluoruracil (5-F.U.) significantly augmented the effectiveness of radiation therapy for locally unresectable carcinoma of the stomach, pancreas and large bowel. Each patient was given radiation therapy delivered by a cobalt-60 teletherapy unit or a 6,300,000-volt linear accelerator. Therapy was administered 6 days each week at a rate of 900–1200 rads per week to a total tumour dose of 3400–4000 rads. In addition to the radiation, each patient received, on a randomized double-blind basis either 5 F.U. or a placebo. Total dose of 5 F.U. was 45 mg per kg of actual or ideal weight, which was less. (UK)

6059 COLONY-FORMING UNITS AND SURVIVAL OF IRRADIATED MICE TREATED WITH AET OR ENDOTOXIN. Ainsworth, E. J.; Larsen, R. M. (Naval Radiological Defense Lab., San Francisco.). Radiat. Res., 40: 149-76(Oct. 1969).

When mice are given radiation exposures producing the hematopoietic syndrome, it is assumed that it is the killing of hematopoietic stem cells and the leuko- and thrombocytopenias which ultimately develop that predispose the animals to infection, hemorrhage and death. The colony-forming unit (CFU) has many attributes of a (the) hematopoietic stem cell, and it might be expected that a high correlation should exist between CFU survival and survival of the animal. Some earlier studies have supported this correlation, whereas, others have not. In the present experiments three CFU methods (endogenous, recipient, and donor) have been used to evaluate this correlation in mice in which survival has been increased with AET or bacterial endotoxin. The results show that the different CFU procedures yield somewhat different results, yet under certain conditions the LD_{50}'s for AET- or endotoxin-treated mice may be predicted within 2 to 10% from CFU survival curves. In spite of the good correlation between CFU survival and probability of survival of the mouse, it is proposed that the CFU is not the stem cell which determines the radiation sensitivity of the mouse. (auth)

6060 RADIOPROTECTIVE EFFECT OF 5-AZACYTIDINE IN AKR MICE. Vesely, J.; Gostof, R.; Cihak, A.; Sorm, F. Z. Naturforsch., 24b: 318-20(Mar. 1969).

The administration of 5-azacytidine to mice (AKR strain) prior to irradiation with a supralethal dose of x rays markedly reduces their mortality. In the pretreated animals the number of blood leukocytes and of bone marrow nucleated cells is considerably higher than in the animals that were only irradiated. It is supposed that the radioprotective effect of 5-azacytidine favorably influences the proliferation of the stem-cells which are responsible for the repopulation of the bone marrow. (auth)

6061 EFFECT OF A MONOAMINE OXIDASE INHIBITOR ON RADIATION PROTECTION BY 5-HYDROXYTRYPTOPHAN. Barnes, J. H.; Lowman, Doreen M. R. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 14: 389-90(1968).

Recent observations suggest that the radioprotective action of 5-hydroxytryptophan (5-HTP) is the result of its conversion to 5-hydroxytryptamine (5-HT) in the body. Further evidence in agreement with this hypothesis is presented. Phenelzine (β-phenylethylhydrazine in the form of the hydrogen sulfate) was given (23.4 mg/kg) to mice two hr and 5-HTP 15 min before irradiation with 950 rad x rays. Although a dose of 400 mg/kg of 5-HTP increased survival of mice after radiation a smaller dose of 100 mg/kg was insufficient. However, when phenelzine was given before 5-HTP, to inhibit monoamine oxidase (MAO) and thus permit accumulation of 5-HT, the number of survivors was very significantly greater than with 5-HTP alone ($P < 0.0001$). Phenelzine by itself was not radioprotective, thus, as was found with another MAO-inhibitor, iproniazid, phenelzine does not induce protection through any build-up of endogenous 5-HT. With 200 mg/kg of 5-HTP, potentiation by phenelzine was less marked in agreement with the hypothesis. (M.M.B.)

6062 INFLUENCE OF ADMINISTRATION OF LANOSTEROL TO SWISS MICE FOLLOWING WHOLE-BODY IRRADIATION. Aubert, C.; Leborgne de Kahouel, C.; Juret, P. (Institut Gustave Roussy, Villejuif, France). Compt. Rend. Soc. Biol., 162: 1037-40(1968). (In French).

In mice exposed to a whole-body irradiation of between 800 and 1100 R, the daily administration of lanosterol caused a decrease in mortality at 800 R and a significantly longer mean survival at 1000 R. The toxic effects of lanosterol are described. (J.S.R.)

6063 STUDIES ON THE MECHANISM OF THE RADIATION PROTECTIVE EFFECT OF PROTEOLYTIC ENZYMES. Danysz, A. (Pharmakologisches Institut der Medizinischen Akademie, Bialystok, Poland); Kocmierska-Grodzka, Danuta; Niewiarowski, St.; Prokopowicz, J. Folia Haematol. (Leipzig), 87: 128-34(1967). (In German).

In agreement with findings reported in the literature, whole body irradiation causes increased activity of proteolytic enzymes. Administration of inhibitors shortly after exposure normalizes enzyme activity in rats if the radiation dose does not exceed 600 R. (H.B.G.)

6064 EFFECTS OF COMBINED ADMINISTRATION OF CEPHARANTHIN, ADENINE, AND ESSENTIAL AMINO ACID MIXTURE ON RADIATION HAZARDS CAUSED BY TELECOBALT THERAPY. Fujii, Tamotsu (Kurashiki Central Hospital, Japan). Kurashiki Chuo Byoin Nenpo, 35: 219-23(May 1967). (In Japanese).

From the results of blood examinations in 60 cases with malignant neoplasm the author investigated the effects of combined administration of cepharanthine, (3 mg per day, orally), adenine (60 mg per day, orally), and essential amino acid mixture (intravenous injection of 40 to 100 cc per day) upon the radiation injuries that develop during ^{60}Co γ therapy (150 R to 300 R/field, and one to two fields per day). The effect was most remarkable for the preventiop of leukopenia, the mean value of the reduction of white blood cell count showing only 12.2%. Out of 56 cases treated with one field irradiation per day, no patients were compelled to discontinue the ^{60}Co teletherapy because of leukopenia. In differential counts, lymphocytes were reduced in number from 31.4% to 17.7% on average at the sixth week after the first irradiation. Both hemoglobin content and red blood cell count showed no significant reduction. (NSA of Japan)

6065 RADIOPROTECTIVE AGENTS: FURTHER RESULTS WITH AMIDOPHOSPHOROTHIOATE AND RELATED COMPOUNDS. Akerfeldt, S.; Roennbaeck, C.; Hellstroem, M.; Nelson, A. (Research Inst. of National Defence, Sundbyberg, Sweden). Radiat. Res., 35: 61-7(1968).

The dose-reduction factor (DRF) of diammonium amidophosphorothioate (Å 331) was determined in mice and related to that of cysteamine (MEA) as an internal standard. In the experiments, 2.1 μmoles of MEA and 0.14 μmole of Å 331 were administered per gram of body weight. At pH 7.7 the value of $DRF_{Å331}:DRF_{MEA}$ was found to be 1.15 ± 0.09, and at pH 10 it was 1.08 ± 0.11. The therapeutic index was 2.9 for Å 331 and 1.3 for MEA. The compound Å 331 was shown not to be protective at pH 3. The reasons for this finding are discussed. Serotonine injected together with Å 331 did not increase the DRF over that of Å 331 alone. A number of derivatives of amidophosphorothioate were synthesized and tested, but none was found to be superior to the parent compound as a radioprotector. (auth)

6066 S-2-AMINOETHYL S′-ω-CARBOXYALKYL DITHIOCARBONATE HYDROCHLORIDES AS POTENTIAL ANTIRADIATION AGENTS. Johnston, Thomas P.; Stringfellow, Carl R. Jr.; Piper, James R. (Southern Research Inst., Birmingham, Ala.). J. Med. Chem., 11: 1256-8(Nov. 1968).

The synthesis of S-2-aminoalkyl S′-ω-carboxyalkyl dithiocarbonate hydrochlorides was undertaken as an extension of previous modifications of the radioprotective agent 2-aminoethanethiol in which the mercapto group is combined in dithiocarbonate esters. The general approach to the preparation of these compounds was based on the dithiocarbonate synthesis developed by Crawhall and Elliott and involved concurrent hydrolytic ring cleavage and ester hydrolysis of the alkyl ω-(2-thiazolin-2-ylthio)alkanoates. The required intermediate esters were prepared by the alkylation of 2-thiazolidinethione with the corresponding alkyl ω-bromoalkanoates. Antiradiation screening tests in mice against lethal x radiation (800 to 825 R) were performed. The compounds were administered intraperitoneally 15 min before irradiation as a solution of suspension ranging from 0.9% for the

most toxic compound to 5% for the least toxic (pH 5 to 7). A table shows the toxicity and 30-day survival values of the mice. Among the dithiocarbonates tested thus far, only S-2-aminoethyl S'-3-carboxypropyl dithiocarbonate hydrochloride showed good radioprotection of mice. It is apparently the least toxic dithiocarbonate listed and hence can be administered at a relatively high, nontoxic dose. It gave 67% 30-day survival in doses of 1 g/kg compared with 0% in control mice. (BBB)

Radiation Sickness and Injuries

6067 ON THE THERAPY OF RADIATION INJURIES IN IRRADIATED SKIN TUMORS WITH A LOCAL ANABOLIC AGENT. Dietz, H. (Staedische Hautklinik, Stuttgart). Med. Welt., 6: 306-8(Feb. 8, 1969). (In German).

Fifty patients with malignant skin tumors were treated either with x radiation or fast electrons. The total dose was about 8000 rads. One group of patients received topical application of Dianabol ointment, a steroid preparation, following exposure, while the other group remained untreated. In the average, steroid treatment accelerated epithelization by six days. Side effects did not occur. It was found that longterm topical treatment with steroid ointment prevented, or decreased, the incidence of late radiation injuries to the skin, especially atrophy, disturbances of pigmentation, and dilatation of blood vessels. (H.B.G.)

6068 A NEW DRUG FOR TREATMENT OF GASTROINTESTINAL SYMPTOMS OF RADIATION SICKNESS. Fochem, K. (Univ., Vienna). Ther. Gegenw, 108: 418-24(Mar. 1969). (In German).

Based on observation of 130 cancer patients, as well as experiments with mice and rats, efficacy of metaclopromide as a treatment for radiation sickness was evaluated. In 110 patients good results were obtained with respect to nausea, anorexia, vomiting, fatigue, and mood depression. The drug proved superior to the routinely administered antiemetica. (H.B.G.)

Radiodiagnosis

Refer also to abstracts 5894, 5896, 6047, and 6048.

6069 IRON ABSORPTION IN IDIOPATHIC HAEMOCHROMATOSIS AND ITS MEASUREMENT USING A WHOLE-BODY COUNTER. Smith, P. M.; Godfrey, B. E.; Williams, R. (King's College Hospital, London. Radiological Protection Service, Sutton, Eng.). Clin. Sci.; 37: 519-31(1969).

Iron absorption measurements determined by a whole-body counter in forty-nine patients with idiopathic haemochromatosis were reported, together with an analysis of the factors, particularly redistribution, affecting such measurements. A significant decrease in the response of the whole-body counter was observed over a 5 hr period ofter oral administration of ^{59}Fe. This resulted from gradual redistribution of iron from the upper abdomen to other sites of the body. The response at early times expressed as a percentage of that at 5 hr was widely scattered and the value of count rate at 5 hr was taken as the most representative. This also corresponded most closely with the distribution found shortly after the same activity was administered intravenously. There was a tendency, statistically significant, for the most marked distribution affects to occur in the heaviest subjects. The mean absorption in the untreated patients was 13.4% (range 2–38), the corresponding values for normal subjects being 14.1% (range 4–25). During venesection therapy there was a marked rise over the initial level with mean values of 43% in the group studied during the first 6 months, and 52% in those studied from 6 to 18 months after the commencement of venesections. In the individual patient, absorption once increased was maintained at a constant and maximum level, even when the patient became iron deficient. Absorption remained high following cessation of treatment after the iron stores had been depleted, averaging 63% in the first year, 52% in the 3rd–5th year and 44% 5–10 years later, the latter value representing a significant decrease. (auth) (UK)

6070 NUCLEAR ACTIVITY OF LESIONS OF THE CERVIX. Thoms, G.; De Groot, R. J. (Cancer Inst., Melbourne). Med. J. Aust.; 2: 635-9(Sep 1969).

This paper reports findings resulting from the investigation of sites of nuclear activity in the cervix. The value of ^{32}P in the differentiation of malignant and non-malignant tissues, when the cells are sufficiently superficial for beta-particle detection, is confirmed. The test has proved to be accurate and rapid. The value of this test as an aid to other investigations in assessing the malignant potential of the "pre-invasive" lesions of dysplasia and carcinoma-in-situ is discussed, and the use of the test as an indication of the efficiency of the destruction of malignant cells by radon therapy is evaluated. (Australia)

6071 POTENTIATED INTRAVENOUS CHOLANGIOTOMOGRAPHY. Govoni, A. F. (General Hospital, Sault Sainte Marie, Ont.); Biolcati-Rinaldi, A.; Toti, A. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 107: 27-36(Sep 1969).

Potentiated intravenous cholangiotomography by infusion of 40 cc of ioglycamide, bilivistan, or 50 cc of iodipamide, in 250 cc of 5% glucose solution, infused in 60 min, results in a very satisfactory visualization of the extrabiliary system. There is simultaneous opacification of the gallbladder and ducts, with minimal or no side-effects and minimal renal excretion of the contrast medium. (auth)

6072 VITAMIN B_{12} ABSORPTION STUDIES: COMPARISON OF ^{57}Co VITAMIN B_{12} PLASMA LEVELS WITH AND WITHOUT PARENTERAL VITAMIN B_{12}. Armstrong, B. K.; Woodliff, H. J. (Royal Perth Hospital, Australia). Med. J. Aust.; 2: 692-3 (4 Oct 1969).

Studies of the vitamin B_{12} absorption tests using ^{57}Co vitamin B_{12} plasma levels have shown that sensitivity is not lost by omitting parenteral injection of an augmenting dose of unlabelled vitamin B_{12}. The simpler test, which avoids premature therapy and the necessity for an injection, is therefore recommended for use as a routine. (Australia)

6073 ^{131}I-3'-IODOAMINOPTERIN: A GAMMA-LABELED ACTIVE-SITE-DIRECTED ENZYME INHIBITOR. Johns, David G.; Spencer, Richard P.; Chang, Pauline K.; Bertino, Joseph R. (Yale Univ., New Haven). J. Nucl. Med., 9: 530-6 (Oct. 1968).

The folate antagonist ^{131}I-3'-iodoaminopterin was prepared as a model for a new type of enzyme-localizing agent with possible diagnostic usefulness: that is, a γ-labeled active-site-directed enzyme inhibitor. After intravenous administration in man, the compound localizes in liver and kidney, organs with high levels of the target enzyme, dihydrofolate reductase. The location of the inhibitor and thus of the enzyme can then easily be determined by external scanning. The liver and kidney radioactivity can be displaced with unlabeled folate analogs such as methotrexate, that then appears in the urine. On chromatography, the greater part of this radioactivity is found to be caused by unchanged ^{131}I-3'-iodoaminopterin. This result could be anticipated only if the displaced radioactivity represented labeled drug which was enzyme-bound. Considerable radioactivity is also seen in the thyroid and is not displaced by folate analogs. Furthermore, the uptake of the thyroid radioactivity is prevented by pretreatment with Lugol's solution. In vivo, therefore, some dehalogenation of ^{131}I-3'-iodoaminopterin occurs to yield free ^{131}I-iodide. (auth)

6074 USES OF ENRICHED STABLE ISOTOPES IN MEDICINE. Bethard, William F. (Iso-Med, Inc., La Jolla, Calif.). Trans. Amer. Nucl. Soc., 12: 461(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6075 ORGAN SCANNING IN INTERNAL MEDICINE. Saito, Tatsuo; Kato, Tomizo (Nippon Medical School, Tokyo). Naika, 24: 227-33(Aug 1969). (In Japanese).

The progress in the last 10 yr of radioisotope scanning, now an established radiodiagnosis in internal medicine, is described. The major aspects of progress were in the development and improvement of equipments and instruments, introduction of new radioiodine and standard compounds for labeling, and clinical application of techniques. A scinticamera developed by Anger in 1958 considerably shortened the time required for scanning and also enabled temporal scanning. Various improvements were made in scanners and other instruments. The radioactive substances recently introduced include short-life and low-energy γ rays such as ^{99m}Tc and ^{113m}In used in the scanning of the thyroid gland, liver, kidney, and brain and ^{133}Xe, in the lung. The methods of scintiscanning for the thyroid gland, liver, lung, spleen, kidney, brain, mediastinum, pancreas, bone marrow, and bones are described. Discussion is given of diagnosis based on the scintigram of these organs and tissues. The diagnostic value of the scintigram was compared with x-ray diagnosis in each organ and tissue. (NSA of Japan)

6076 RADIOLOGICAL DETECTION OF DUST DEPOSITED IN THE LUNGS: INVESTIGATIONS CONDUCTED WITH THE ALDERSON–RANDO PHANTOM. Goebbeler, Th.; Klosterkoetter, W.; Loehr, E.; Magnus, L.; Scherer, E. Beitr. Silikose-Forsch., No. 97, 1-21(1968). (In German).

In view of the differing views and results obtained regarding the possibility of showing dust deposits in the lungs by radiological methods, experiments were conducted with pit dust using the Alderson–Rando phantom to simulate the human body and aimed at determining the smallest amount of dust that could be

detected by radiography. Details are given of the apparatus and method used and of the results obtained. It was concluded that pit dust accumulated in silicotic lungs contributes to the formation of opacities appearing in radiographs. (Occup. Safety and Health Abstr.)

6077 COMBINED SCINTIGRAPHY OF SPLEEN AND KIDNEYS USING ^{197}Hg LABELED BMHP. Gotta, H.; Rochna Viola, E. M.; Musso, A. M.; Kremenchuzky, S.; Pecorini, V. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl.-Med., 8: 166-78(July 15, 1969). (In German).

^{197}Hg-BMHP was used for a simple, rapid, and nonhazardous method for scanning first the spleen and then the kidneys. In patients with suspected splenic disease and in particular in the differential diagnosis of tumors in the left hypochondrium this technique was of considerable value. (auth)

6078 USE OF TIN-^{99m}TECHNETIUM FOR CARTOGRAPHY OF THE LUNGS BY PERFUSION. Morcellet, J.-L.; Blanchet, C.; Le Mignant, A. (Centre d'Etudes et de Recherches Bio-Physiologiques, Toulouse). J. Biol. Med. Nucl.; 4: No. 17, 16-18(May-June 1969). (In French).

The method for preparing macroaggregates of Sn-^{99}Tc is described. The average diameter of the particles as observed under the microscope was 30 μm. A table is presented to show the distribution of particles in the blood, liver, lungs, spleen, and kidneys of rats. The increase of the concentration of ^{99}Tc in the liver was parallel to its diminution in the lungs. Chemical and radio-toxicity of the preparation and use of the preparation for scintigraphy of human lungs are discussed. Cartographies were obtained very rapidly; a maximum speed of 10 mm/sec was used. This preparation gave better results compared with other preparations of Sn-^{99}Tc or with macroaggregates of serum albumin. Owing to its effective pulmonary period, the radiation dose to the patient is much less than that delivered by ^{131}I. (H.L.W.)

6079 LUNG SCANNING IN DETECTING PULMONARY EMBOLIC DISEASE. Johnson, Philip M.; Parker, Bruce R.; Cosgriff, Stuart W.; Ellis, Kent (Columbia Univ., New York). N. Y. State J. Med., 69: 2870-4(Nov. 15, 1969).

The accuracy of lung scanning to detect pulmonary embolism was evaluated retrospectively in 326 patients clinically suspected of having pulmonary embolism at the time of scanning. The results of the lung scan and the final clinical diagnosis agreed in 70% of cases and disagreed in 11%; in 19%, the scan was equivocal. When only the unequivocally positive or negative lung scan result was considered, it was found that a positive finding was present in 89% of patients with a final diagnosis of pulmonary embolism, and a negative scan result in 84% of those without embolism. Although the unequivocal scan finding is clearly useful when pulmonary embolism is suspected, the significant incidence of equivocal, false-positive, and false-negative scan results preclude uncritical reliance on this diagnostic method. (auth)

6080 UNCERTAINTIES AND CAUSES OF ERROR IN PERFORMING AND INTERPRETING SCINTIGRAPHIC EXAMINATION OF THE LIVER. Lin, S.; Ucmar, F. (Ospedali Riuniti, Trieste, Italy). Minerva Med. Giuliana; 8: 416-29(Sep-Oct 1968). (In Italian).

Reference is made to the physico-chemical, technical and biological factors which condition the correct performance and interpretation of scintigraphic examinations of the liver. It is suggested that dilution of the colloid suspension of radio-gold with solutions containing electrolytes is unsatisfactory from both a theoretical viewpoint and at electron microscopy of micella behavior. After brief mention of the importance of certain elements of the scintigraphic apparatus in determining the degree of resolution of the instrument and the clarity of the information, the margin of error which the chance nature of radioactive events introduces into interpretation of a liver chart with consequent statistical measurement error is discussed. The principal morphological variations of the healthy and sick liver and some scintigraphic pictures of hepatopathies with cirrhogenous course are illustrated. In the light of recent findings in hepato-splenic physiopathology, some hemodynamic mechanisms which may partly explain the particular scintigraphic aspects of the cirrhotic liver are listed. (auth)

6081 INTRAVENOUS CHOLANGIOTOMOGRAPHY WITH BILIVISTAN. REPORT ON A NEW CONTRAST MEDIUM FOR THE VISUALIZATION OF THE EXTRABILIARY SYSTEM. Govoni, A. F. (General Hospital, Sault Sainte Marie, Ont.); Toti, A. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 107: 14-20(Sep 1969).

The advantages of bilivistan can be summarized as follows: Better tolerance to the contrast medium; simultaneous visualization of the whole extrabiliary system, that remains opacified for a long period of time; no tying down of a radiographic room for an unnecessarily long time, since the injection can be performed in the hospital ward, or in a nonradiographic room if the patient is examined on an ambulatory basis. This is because the first cholangiogram is usually taken 60 min from the time of injection; examination requiring fewer roentgenograms, resulting in a decrease in the radiation exposure of the patient and also in a diminished cost of the examination; satisfactory tomographic studies of the topographic anatomy of the gallbladder and ducts; excellent visualization of the function of the extrabiliary system by pharmacologic studies because of the simultaneous and protracted opacification of the gallbladder and ducts; and use of a contrast medium that can also be injected intramuscularly without discomfort to the patient. (auth)

6082 GAMMA ENCEPHALOGRAPHY. POSSIBILITIES AND LIMITATIONS OF DIAGNOSIS OF GLIOBLASTOMAS. Planiol, Therese (Regional Hospital Center, Tours, France). Acta Radiol., Ther., Phys., Biol.; 8: No. 1-2, 86-91(Feb-Apr 1969). (In French).

Five hundred cases of glioblastoma were analyzed with gamma encephalography in order to define the limitations of the method in the diagnosis of cerebral tumors. However refined the techniques employed, it seems that a proportion of 2 to 4% of glioblastomas escape detection due to technical or biologic factors. The nature of the lesion can in most cases be determined but the criteria obtained are not decisive and have to be corroborated by the clinical and radiographic findings; the most common sources of error are stated. The results seem to be influenced by the choice of radioactive substance. (auth)

6083 USE OF ^{203}Hg NEOHYDRIN IN ASSESSMENT OF RENAL FUNCTION IN NON-VISUALIZING KIDNEY. Moon, Hyo Joong (Pusan National Univ., Korea). J. Nucl. Sci. (Seoul), 9: No. 1, 147-59(1969). (In Korean).

Renal scanning with ^{203}Hg-neohydrin was done in forty-three cases in which no excretion was visible by intravenous pyelography. Twenty-one of the kidneys involved were also weighed and connections between weight and scanning results were examined. Of the forty-three cases, no renal scanning was depicted in about two-thirds. In about one-third of the cases excellent to poor uptake was depicted, showing normal to decreased functional pattern in the renal parenchyma. Of the twenty-one kidneys, the total renal weight was found to be generally increased. After removal of contents of the grossly diseased areas, there were no significant deviations from normal renal weight. The macroscopically and microscopically normal parenchyma was also weighed and found to vary from naught to a normal figure. The weight of parenchyma that was normal in appearance was in each case, closely correlated with the ^{203}Hg-neohydrin renal scanning results. ^{203}Hg-neohydrin renal scanning was considered to be a highly valuable method for determining function in renal parenchyma in cases showing no excretion by intravenous pyelography. (auth)

6084 BLOOD-POOL SCANNING OF THE HEART AS A DIAGNOSTIC AID. Andrews, J. T.; Stevens, L. W.; Greenberg, P.; Murray, R. (Royal Melbourne Hospital, Melbourne). Med. J. Aust.; 2: 755-7(11 Oct 1969).

A technique is described for rapid and safe scanning of the heart blood pool. Its usefulness in differentiating a pericardial effusion from a dilated heart is illustrated by two examples. The merits of ^{113m}In in this investigation are discussed and comparisons are made with other isotopes. (auth) (Australia)

6085 CONTACT MICROROENTGENOGRAPHY OF HISTOLOGICAL SECTIONS WITH THE AID OF RADIOACTIVE IRON (^{55}Fe) IRRADIATION. Lobov, S. I.; Pavlovskaya, N. G.; Ponedelko, V. P.; Tsukerman, V. A. Arkh. Patol.; 31: No. 9, 72-7 (1969). (In Russian).

A method of contact microroentgenography of thin histological sections with the aid of soft x-ray irradiation of ^{55}Fe isotope is described. Roentgenograms with 10 to 50 times enlargement are received in the areas of x-ray spectra with long wave lengths. This permits analysis of calcium, potassium, chlorine, silicium, and other element distribution in structures fixed on the microroentgenogram. Examples of microroentgenograms of various histological sections obtained in the wave length range characterizing spectrum x-rays from 2.1 to 7.1 Å are presented. (auth)

6086 DEGREE OF RADIATION LOAD OF THE YOUNG CHILD THROUGH X-RAY OF THE PELVIS. Seyss, R. (Roentgenabteilung des Krankenhauses, Neunkirchen, Austria). Kinderaerztl. Prax., 36: 315-8(July 1968). (In German).

Development of a new method is described for x-ray examination of the pelvis of infants. Exposure time is controlled by a dosimeter

located in the radiation field. Special methods for protecting every part of the pelvis except the hip joint are discussed. Actually received doses with the new method are compared with those reported in the literature. (H.B.G.)

Radiotherapy

Refer also to abstracts 5784, 5938, 6026, 6044, 6045, 6058, 6130, 6131, 6133–6139, and 6798.

6087 IRRADIATION OF MULTIFORM GLIOBLASTOMAS: RESULTS OF CONVENTIONAL RADIOTHERAPY AND GAMMA THERAPY WITH REGARD TO 87 CASES. Legre, J.; Amalric, R.; Padaut, J. (Hopital de la Timone, Marseille). Acta Radiol., Ther., Phys., Biol.; 8: No. 1-2, 118-25(Feb-Apr 1969). (In French).

The results of postoperative radiotherapy in 87 cases of glioblastoma multiform were analysed according to well defined anatomical criteria. A comparison was made of results obtained by conventional radiotherapy and gamma therapy. Two factors are of prime importance in the survival of the patients: the optimal dose should be in the range 5,000 to 7,000 rad, superior or inferior doses compromising the results; the volume irradiated should comprise the whole cerebral hemisphere, the tumour site, because of the infiltrative nature of cerebral tumors. (auth)

6088 RADIOTHERAPY OF MALIGNANT TUMORS BY 6 MeV CLINICAL LINEAR ELECTRON ACCELERATOR. Tatsuno, Ikuro; Izumi, Naganari (Kanazawa National Hospital, Japan). Iryo, 23: 877-87(July 1969). (In Japanese).

Single field or two portal opposing fields and tangential irradiation were used for x ray therapy. Electron therapy was used only for skin metastasis or superficial lymph nodes metastasis because electron energy was fixed at 6 MeV even at maximum. Some cases of huge keloid were treated by electron beam irradiation. Daily radiation doses were gradually increased for the prevention of the radioinduced inflammation of mucous membrane. One year survival rates of surgery plus irradiation and irradiation alone were followed up. Survival rates were compared for patients with each tumor stage. Cancer of the uterine cervix, breast cancer, and thyroid cancer showed excellent results. Extended whole pelvic irradiation was applied for some cases of cancer of the uterine cervix instead of intracavitary radium plus external pelvic irradiation. The results showed remarkable effects based on the clinical findings, the smear-test, and biopsy specimens. The smear test was characteristic and an easy indicator to show the therapeutic course. (NSA of Japan) (TSS)

6089 OPTIMIZATION OF THE MIT REACTOR MEDICAL FACILITY. Sanders, R. C.; Thompson, T. J. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 795-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6090 LARYNGEAL CARCINOMA 3 YEARS AFTER RADIOTHERAPY OF A LARYNGEAL SARCOMA. Wirth, G. (Univ., Heidelberg). Arch. Klin. Exp. Ohren-, Nasen-, Kehlkopfheilk., 191: 745-8(1968). (In German).

A laryngeal squamous cell carcinoma developed 3 yr after treatment of a laryngeal sarcoma with 5320 R of ^{137}Cs irradiation in a patient who had been a heavy smoker. When the larynx was removed there was no evidence of the earlier treated sarcoma. The carcinoma was keratinized and extensive. On the basis of similar cases reported previously, and because of the previous history of heavy smoking by the patient, it was concluded that the carcinoma had been induced by the previous irradiation treatment of the original sarcoma. (BBB)

6091 PREVENTION OF ESTROGEN-INDUCED GYNECOMASTIA BY EXTERNAL IRRADIATION. Wolf, Hans; Madsen, Paul O.; Vermund, Halvor (Veterans Administration Hospital, Madison, Wis. Univ. of Wisconsin, Madison). J. Urol., 102: 607-9(Nov. 1969).

Previous reports on successful prevention of gynecomastia in patients with prostatic cancer treated with estrogens by external irradiation of the breast were studied and confirmed. The patients received 1,000 Rads to one nipple area and the other side served as control. The prevention was effective throughout the observation period of more than 2 years. (auth)

6092 BETA THERAPY IN THE MANAGEMENT OF SKIN ANGIOMA. Passerini, A.; Milani, F.; Palmia, C. (Univ., Milan). Radiol. Med., 55: 870-8(Sept. 1969). (In Italian).

The treatment of angiomas with radium therapy is reviewed and an account is given of cases irradiated with contact beta therapy at the Department of Radiology of the University of Milan. The advantages of the technique are stressed and emphasis is also laid on the harm that may be caused by an excessive dose. Careful selection of patients is recommended and it is pointed out that the deeper angiomas may still be treated with radium, at least in the initial stages. (auth)

6093 TUMOR EXTENT AS A DETERMINING FACTOR IN RADIOTHERAPY OF GLIOBLASTOMAS. Kramer, Simon (Jefferson Medical Center, Philadelphia). Acta Radiol., Ther., Phys., Biol.; 8: No. 1-2, 111-17(Feb-Apr 1969).

Failure to cure highly malignant gliomas may be due to an underestimate of the tumor extent. Twenty-one patients were planned for irradiation (chosen target volume as a rule 10 cm × 8 cm × 8 cm) but death occurred before effective therapy was given. When the treatment plan was compared with the tumor extent in the autopsied brain, only two out of the twenty-one patients were found to have had adequate tumor coverage. If the target volume had been doubled (12 cm × 10 cm × 9 cm) one-fifth of the patients would still have had inadequate tumor coverage. We conclude that the whole brain should be irradiated for glioblastomas. (auth)

6094 TECHNIQUE OF STEREOTAXIC PROTON IRRADIATION OF THE HYPOPHYSIS AND OTHER CEREBRAL REGIONS. Konnov, B. A.; Volkov, A. A.; Malevich, M. A.; Nizkovolos, V. B. (Kharkov Research Inst. of Medical Radiology). Med. Radiol.; 14: No. 10, 53-62(Oct 1969). (In Russian).

The successful use of beams of protons and alpha-particles is possible only upon condition of maximally precise determination of the localization of the irradiation object. A self-centering device was designed for this purpose that modeled the apparatus for irradiation, and involved the principle of a pendulum stereotaxic appliance. The proposed technique enables radiosurgical interventions in different regions of the brain. (auth)

6095 MEASUREMENT OF CORONARY COLLATERAL BLOOD FLOW USING RADIOACTIVE RUBIDIUM CHLORIDE. Quattlebaum, Frank W.; Edlich, Richard F.; Lillehei, C. Walton (Univ. of Minnesota, Minneapolis). Surg. Gynecol. Obstet., 129: 1034-8(Nov. 1969).

The distribution of ^{86}Rb and radioactive microspheres between ischemic and nonischemic myocardium have been simultaneously compared in dogs, after ligation of the anterior descending branch of the left coronary artery. The uptake of these two independent indicators of blood flow by the canine heart after occlusion of the coronary artery did not differ significantly. The agreement between the partition of ^{86}Rb and radioactive microspheres is considered strong evidence that both of these clearance techniques provide a correct measure of the distribution of blood flow within the canine heart after ligation of the coronary artery. (auth)

6096 CHALLENGE OF RADIATION BIOLOGY. Tolmach, L. J. (Washington Univ., St. Louis). Your Radiol. (Chicago), 11: 29-35(Winter 1968).

Selected topics of radiobiology are reviewed and their application to cancer radiotherapy is discussed. Advances in radiotherapy have resulted directly from the application of quantitation to radiation-produced cellular damage, most notably the measurement of loss of cell viability, that is, the cell's capacity to undergo unlimited proliferation. The development of procedures to permit quantitation of the loss of viability of cell populations exposed to measured amounts of radiation is discussed. The most important findings from these measurements are that mammalian cells are extremely sensitive to x rays (on the order of from 100 to 1000 times more sensitive than bacteria) and that virtually all the mammalian cells that have so far been studied (normal or malignant, established lines or fresh explants) differ in their sensitivity toward x or γ rays by only a factor of about 6 between the least and most sensitive. How cells undergo spontaneous repair after x irradiation is also considered in 2 types of repair; also, how the sensitivity of cells varies with their position in the generation cycle. Applications of radiobiological findings to the treatment of patients with cancer include exploitation of the oxygen sensitization of biological systems. Another attempted therapeutic innovation has been that of sensitization by prior replacement of the thymidine of tumor cell DNA by its halogenated precursors. A third possible application of radiobiology to therapy takes advantage of the fact that the nearly exponential response of cell populations to x rays results in a relatively small dose (e.g., 500 rad) being able to kill a large fraction of tumor cells, even though it cannot sterilize the tumor nor cure the patient. If such a dose is applied to a tumor before surgical excision of the mass, the probability of spilling viable tumor cells into the circulation during surgery can be reduced. (BBB) (TSS)

Blast and Thermal Effects

6097 THE EFFECTS OF RADIATION ON CHROMOSOMES OF BONE MARROW CELLS. 3. CYTOGENETIC STUDIES ON LEUKEMIA IN ATOMIC BOMB SURVIVORS. Kamada, Nanao (Hiroshima Univ.). Nippon Ketsueki Gakkai Zasshi, 32: 249-74(Apr. 1969).

Data from physical and hematological cytogenetic studies on 17 cases of leukemia among those related to the A-bomb exposure and 37 cases among those without any relations to bomb exposure, are reviewed. For chronic granulocytic leukemia, comparison of the physical and clinical laboratory findings of the six exposed and eight non-exposed cases showed that the trend of the former was milder than the latter. No conclusion can be drawn at present as to whether this is peculiar to radiation-induced leukemia or is age related because of the fact that the exposed leukemia patients were of higher age. Chromosome studies showed that all cases in both groups had Ph^1 chromosomes at a high frequency. The frequency of Ph^1 chromosomes was not related to the peripheral WBC count, or therapeutic effects, or to neutrophil AP value. There were no findings to indicate that the tendency of aneuploidy and pseudodiploidy was high in chronic granulocytic leukemia of the exposed. For chronic granulocytic leukemia it was not possible to detect any differences in the physical and clinical laboratory findings in one exposed and three non-exposed patients in this category. Chromosome study showed an increase in aneuploidy and additional karyotype abnormalities besides the presence of Ph^1 chromosome following acute exacerbation. The exposed patient had a chromosome count of 47 with 2 Ph^1 chromosomes. All four cases had high neutrophil AP values prior to and after blastic crisis. For acute leukemia the peripheral leukocyte counts of 10 exposed and 26 non-exposed leukemia cases were studied, but the former showed no tendency of aleukemic leukemia being more frequent. There were no differences in the physical and clinical laboratory findings, nor was there any statistically significant difference in the survival time. Chromosome studies showed that six of the 10 exposed cases had karyotype abnormalities, but abnormalities common to all were not noted. Ten of the 26 non-exposed cases had karyotype abnormalities, and six of the 10 had low neutrophil AP values. These six had a common abnormal finding, that is, missing or translocation in Group G. This finding together with those of the neutrophil AP value and the presence of a hemopoietic gene in the Group G chromosomes seems to be of great interest. The presence or absence of clinical pecularities in chronic granulocytic leukemia in the exposed, possible relationship between Group G chromosome and neutrophil AP value in acute granulocytic leukemia, and the leukemogenesis of radiation in human beings are discussed. (NSA of Japan)

6098 THE EFFECTS OF RADIATION ON CHROMOSOMES OF BONE MARROW CELLS. 2. STUDIES ON BONE MARROW CHROMOSOMES OF ATOMIC BOMB SURVIVORS IN HIROSHIMA. Kamada, Nanao (Hiroshima Univ.). Nippon Ketsueki Gakkai Zasshi, 32: 236-48(Apr. 1969).

The bone marrow picture and the chromosome analysis of bone marrow cells of A-bomb survivors residing in Hiroshima who were in apparent good health both subjectively and physically were studied, and the following results were obtained. The bone marrow picture of survivors 20 years after the bombing showed some statistically significant differences in the appearance of plasma cells, but most failed to show other significant differences from that of their controls. However, it is a fact that at present there are survivors with moderate anemia and not a few cases of leucopenia. Considerations were made on the necessity to carry out studies on their bone marrow picture as well as the bone marrow function in parallel with the research work of others. The chromosome analysis of bone marrow cells of 47 survivors and 17 non-exposed persons failed to demonstrate the increasing tendency of aneuploidy which might be expected to be present among the exposed. Further, no radiation induced chromosome aberrations such as rings, fragments, dicentrics, nor exchanges could be found in either of the two groups. On the basis of these findings, conclusions were made on the dichotomy of chromosome aberrations in the peripheral blood and bone marrow cell. (NSA of Japan)

Radiation Effects on Animals

Refer also to abstracts 6029, 6096, and 6144.

6099 DOSE-RESPONSE CURVES FOR AGENTS THAT IMPAIR CELL REPRODUCTIVE INTEGRITY: II. THE RELATION BETWEEN DOSE-RESPONSE CURVES AND THE DESIGN OF SELECTIVE REGIMENS IN CANCER CHEMOTHERAPY. Berenbaum, M. C. (St. Mary's Hospital Medical School, London). Brit. J. Cancer, 23: 434-45(June 1969).

Agents such as antimetabolites, alkylating drugs, and ionizing radiation, that act mainly by impairing cell reproductive integrity, inevitably damage proliferating populations of normal cells, such as those of the bone marrow or intestinal epithelium. The main clinical problem in using such agents to treat neoplasms or suppress unwanted immunological responses is therefore one of selectivity. It is shown here that the relative selectivity of these agents for various cell types is not an unalterable characteristic of the agent but may depend to a considerable extent on the therapeutic schedule, that is, the size and frequency of doses. The dose-response curves of several clinically useful agents were found to be either exponential or hyperbolic. As a simple exponential curve, the example is cited of the survival of mouse lymphoma cells after irradiation, L1210 cells after treatment with 1,3-bis(2-chloroethyl)-1-nitrosourea, and of hemopoietic stem cells after treatment with cyclophosphamide. Usually, exponential curves have a shoulder, due possibly to multiplicity of cell targets or to repair mechanisms, or both. In the simplified model proposed, the fate of growing or steady-state cell populations treated with a cell-sterilizing agent may be predicted from equations containing two types of parameter: those determined by the dose-response curve and the proliferative or recuperative characteristics of the cell populations and those determined by the therapeutic regimen (i.e. size, frequency, and number of doses). If the values of the former are known, those of the latter may be adjusted to ensure either destruction or survival of the cell population. Different cell types show different dose-response curves to the same agent and have different proliferative or recuperative rates. Regimens may therefore be chosen that selectively damage one cell population while allowing another in the same individual to survive. (BBB)

6100 PROLIFERATION KINETICS AND CELL SURVIVAL OF X-IRRADIATED MAMMALIAN CELLS IN VITRO. Thompson, Lawrence Hadley. Houston, Tex.; Univ. of Texas Graduate School of Biomedical Sciences (1969). 138p.

Thesis.

The response of x-irradiated mouse L-P59 fibroblasts grown in vitro was analyzed in terms of proliferation kinetics and cell survival. Parameters of proliferation were measured with a technique of large-field (1.4 cm^2) time-lapse photography. From photographic records cell pedigrees were constructed for seven or more postirradiation generations and then analyzed to obtain proliferation parameters. At the time of irradiation, the age of any cell (or time since mitosis) could be determined from pre-irradiation photographs. Irradiated cells of specific ages were analyzed by selecting age groups which corresponded to phases of the cell cycle: early G_1, S, and G_2. Radiation doses of 100, 216, 230, 500, and 1000 Rads were employed. The use of lead shields in the modified culture vessel during irradiations provided control (unirradiated) and irradiated cells in the same analysis field, as well as multiple dose regions within a field. Parameters of proliferation showed the following characteristics: Probability of division, p, was highest for early G_1 cells and their progeny, lowest for cells of the G_2 group; e.g., after 1000 Rads p for early G_1, S, and G_2 cells at first division was 0.93, 0.80, and 0.53, respectively. At first division, p was less affected than at subsequent divisions; cell death in some pedigrees was absent until the fourth generation or later. Delay before the first division was greatest for G_2 cells and least for early G_1 cells. In postirradiation generations, generation times were less prolonged, and G_1-group progeny were often affected as much as those of S or G_2 cells. Generation times in abortive clones were usually longer than in viable clones. Frequency of radiation-induced abnormal mitosis (multipolar, daughter fusion) was significantly higher for S and G_2 cells compared to G_1 cells. This phenomenon could have produced as many as 40% of the nonsurvivors at doses ≤230 Rads, but it did not appreciably increase in frequency with dose. Cells which failed to divide were derived from parents whose generation times were ~30% longer than those of parents which produced dividing daughters. Probability of division varied substantially both within and between pedigrees. Closely related cells tended to behave alike with respect to division. Among viable clones after ≤230 Rads, first-division lethal sectoring occurred among early G_1 as well as S and G_2 cells, suggesting that nonspecific chromosome damage was not the major cause of cell killing. Proliferation parameters of V79-S171 Chinese hamster cells for two postirradiation (430 Rads) divisions had age dependencies which were qualitatively different from those of L cells. In survival experiments with L-P59 cells, synchronized populations of mitotic cells (MI ≈ 85%) were obtained by selective detachment and later irradiated in early G_1 (3.5 hours), S (13 hours), and G_2 (18 hours). Purity of G_2 popula-

tions was improved by addition of Colcemid and H^3TdR to eliminate G_1, S, and mitotic cells. Early G_1 cells were the most resistant ($D_0 \simeq 115$ to 120 Rads, $m \simeq 20$ to 100) and G_2 cells were the most sensitive ($D_0 \simeq 80$ Rads, $m \simeq 30$ to 50), S cells being intermediate ($D_0 \simeq 80$ to 90, $m \simeq 100$). (Disser. Abstr.)

6101 DIFFERENTIAL RESPONSE OF RAPIDLY AND SLOWLY PROLIFERATING HUMAN CELLS TO X IRRADIATION. Little, John B. (Harvard School of Public Health, Boston). Radiology, 93: 307-313(Aug. 1969).

The entry of G_1 cells into the DNA-synthetic (S) phase is a radiosensitive process in primary human amnion cell cultures which consist of slowly proliferating cells. When a rapidly proliferating line of cultured human cells was allowed to reach the stationary or plateau phase of growth, the initiation of DNA synthesis was also delayed by a single dose of radiation. This effect was not observed in several lines of human cells irradiated with 1,000 R during exponential growth. In addition, survival curves obtained during the exponential and plateau phases of growth were also significantly different. This differential effect of irradiation in slowly and rapidly proliferating human cell systems in vitro is discussed as it may relate to the effects in normal tissues in vivo, or to those in the non-growth fraction of tumor cells exposed to fractionated or continuous irradiation. (auth)

6102 QUANTITATIVE STUDY OF RADIATION EFFECTS IN PHYTOHAEMAGGLUTININ-STIMULATED LEUKOCYTE CULTURES. Conard, R. A. (Brookhaven National Lab., Upton, N. Y.). Int. J. Radiat. Biol.; 16: 157-65(1969).

Effects of x-irradiation (up to 1500 R) were quantitatively studied in human peripheral blood leukocyte cultures, with and without PHA stimulation, by electronic enumeration and sizing of cell nuclei. Without PHA a dose-dependent reduction of lymphocytes was seen, which was less marked than that resulting from in vivo irradiation. In studying the differential effect of irradiation on blast forms and cell division in PHA-stimulated cultures, vinblastine sulfate was used to arrest cell division. A dose-dependent effect was noted on both blast formation and cell division, but the effect on cell division was much greater. Cultures irradiated after blastogenesis had occurred also showed that the blast forms were not nearly so much affected as was further cell division. Labeling with tritiated cytidine in both irradiated and unirradiated cultures resulted in blast forms that were more heavily labeled than the nontransformed cells. This suggested that the metabolically more active cells were the ones responding to PHA and might be less radiosensitive. On the other hand radiosensitivity as reflected by diminished cell proliferation was pronounced in these cultures. The action of PHA on blastogenesis was discussed in relationship to metabolic alteration of the cell in preparation for cell division. (auth) (UK)

6103 RADIATION PROTECTION IN MAMMALIAN SPINAL GANGLION CULTURES TREATED WITH AET DERIVATIVES. LIGHT- AND ELECTRON-MICROSCOPIC AUTORADIOGRAPHIC STUDIES. Masurovsky, Edmund B.; Bunge, Richard P. (Columbia Univ., New York). Acta Radiol., Ther., Phys., Biol.; 8: No. 1-2, 38-54(Feb-Apr 1969).

Studies of irradiation protection in mammalian spinal ganglion cultures revealed that transguanylated AET derivatives (MEG and GED) provide significant protection to essential cytoplasmic organelles (mitochondria, Golgi complex, ergastoplasm) and nuclear structures in neurons as well as in other cells present in these cultures. Light- and electron-microscopic autoradiography, using ^{35}S-AET, indicated widespread AET-binding, especially in relation to the aforementioned structures. These observations, in concert with previous studies by others, point to an apparently close correlation between cellular radiation protection and the presence of AET derivatives in vital cytoplasmic and nuclear structures. (auth)

6104 IN VITRO STUDIES ON THE EFFECT OF ROENTGEN RADIATION ON THE ERYTHROCYTE METABOLISM. Moser, K.; Schwarzmeier, J.; Lujf, A. (Univ., Vienna). Folia Haematol. (Leipzig), 90: 296-302(1968). (In German).

X radiation in doses up to 50,000 R was administered either to whole blood or to washed erythrocytes. Various enzymes related to metabolism were studied at a temperature of 25°C. Within the given dose range radiation did not affect erythrocyte metabolism. (H.B.G.)

Invertebrates

6105 TUMORIGENIC EFFECT OF X-RAYS ON DROSOPHILA AFTER PARTIAL IRRADIATION ON NON-SEGMENTED EGGS. Gheleiovitch, S. (Institut du Radium, Paris). Int. J. Radiat. Biol.; 16: 15-26(1969). (In French).

X-irradiation of the anterio (nucleated) half of Drosophila non-segmented egg produces the same tumorigenic effect as irradiation of the whole egg. X-irradiation of the posterior (un-nucleated) half of the non-segmented egg has no such effect. Irradiation of any part of the 60-min old egg, in which the nuclei are also present in its posterior half, produces a tumorigenic effect. These results are not sufficient to explain the observed effect by damage to the nucleus. The former data concerning induction of tumour formation by incorporation of tritiated thymidine or uridine into the Drosophila larvae therefore remain unexplained. The hypothesis that appears to reconcile all experimental data is to suppose that damage induced on the cytoplasmic area surrounding the nuclei in Drosophila zygote is responsible for the radiotumorigenic effect reported. (auth) (UK)

6106 EFFECTS OF GAMMA-RADIATION ON EGGS OF DACUS ZONATUS (SAUNDERS). Bughio, Abdul Rahman (Atomic Energy Agricultural Research Centre, Tando Jam, Pakistan); Qureshi, Zafar A.; Mecci, A. K. Int. J. Radiat. Biol.; 16: 183-92(1969).

The effects of gamma-radiation (2 to 12 KR) were determined on the eggs of different age-groups of Dacus zonatus. When 4- to 5-hour-old eggs were irradiated, the larvae failed to hatch at 2 KR and higher doses, whereas 74 per cent hatched in control. None of the doses could prevent hatching following irradiation of 23- to 24- and 29- to 30-hour-old eggs, but the hatch percentage decreased as the dose increased. However, at 4 KR or higher doses, there was severe pupal mortality, and no normal adult emerged following irradiation of 23- to 24- and 29- to 30-hour-old eggs. Most of the adults that emerged from these two age-groups after 2, 4, and 6 KR were structurally deformed. Studies on the larval development revealed that the life-span of larvae was increased appreciably following irradiation of 23- to 24- and 29- to 30-hour-old eggs at 4 KR and higher doses. (auth) (UK)

6107 PLANARIA: HOW THEY ARE AFFECTED BY DIRECT RADIATION AND BY IRRADIATED FOOD. Corbridge, Ann. J. Colo. Dent. Ass.; 45: 22-5(Mar 1967).

Effects of small doses (2 R) of ^{60}Co γ radiation on planaria were studied. There were some immediately noticeable changes in behavior patterns, although no physical changes could be observed. The irradiated planaria did not respond to shock, and could not be trained to give a conditioned response. Planaria which had been trained to give a conditioned response lost their conditioning after irradiation. Ten months after exposure to 2 R, examination with a microscope revealed the exposed planaria were changed in shape, and were wider in the mid-section. Buds or projections from the parent planaria were seen which, when cut off, in turn developed protuberances which grew eyes and a triangular head. Five generations of abnormal planaria were produced in this way. Attempts to reproduce these planaria by eggs were unsuccessful. When planaria were exposed to 4000 and 20,000 rad, they showed no immediate evidence of physical damage. However, they did not respond normally to shock and could not find food in a maze. The first microscopic indication of damage was a darkening of the area around the nervous system. The eyespots changed in size and shape. Frequently the dark pupils moved or disappeared entirely. The planaria gradually lost their ability to move, and the heads of the worms lost their triangular shape. The planaria became noticeably smaller. The heads became totally black and gradually the body darkened until it was entirely black, also. The planaria died, all in less than 5 weeks after exposure. Some planaria which received 4000 rad survived when put in a DNA solution. Raw liver which had received 2 or 4.8 Mrad of radiation from ^{60}Co was fed to planaria every week for 6 months. The planaria fed irradiated liver were smaller in size and decreased in number. (BBB)

Vertebrates

Refer also to abstracts 5986, 5989, 5992, 5997, 5998, 6000, 6003, 6012, 6020, 6026, 6049, 6059—6061, 6065, 6066, 6068, and 6155.

6108 (AD-682904) EFFECTIVENESS OF DRUGS IN ANIMALS EXPOSED TO MIXED GAMMA–NEUTRON RADIATIONS. VI. PRESSOR DRUGS. Davis, L. W.; Brown, J. A.; Strike, T. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Sept. 1968. 27p. (AFRRI-SR-68-20). CFSTI.

Aortic pressure, right atrial pressure, heart rate, and cardiac output were measured, and mean pressure, stroke volume, and peripheral resistance were calculated in 27 beagles before and after 5000- or 10,000-Rad whole-body doses of mixed gamma-neutron radiations. The response of these beagles to levarterenol, phenylephrine, or metaraminol was also determined before and after irradiation. Irradiation caused a decrease in aortic pressure, cardiac output, and stroke volume and an increase in heart rate.

Peripheral resistance increased, but not significantly, in irradiated beagles. Phenylephrine and metaraminol were equally effective before and after the dogs were irradiated, while levarterenol was more effective in irradiated dogs. (auth) (USGRDR)

6109 (AD-691412) VISUAL DISCRIMINATION PERFORMANCE IN THE MONKEY FOLLOWING A 2500-RAD PULSE OF MIXED GAMMA-NEUTRON RADIATION. Germas, J. E.; Fineberg, M. L.; de Haan, H. J. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Apr. 1969. 22p. (AFRRI-SR-69-8). CFSTI.

Six monkeys, trained to perform a series of visual discriminations, were exposed to a 2500-Rad pulse of gamma-neutron radiation. Performance decrements occurred during the first 2 hours postirradiation, with three of the monkeys exhibiting one or more severe decrements involving complete cessation of response. By 90 minutes postirradiation considerable recovery was exhibited. During later postirradiation testing sessions, the performance of four of the animals was comparable to the base-line level for a period of at least 120 hours. Of the two remaining animals one performed close to the base-line level for 24 hours while the other seldom reached the base-line level of performance. (auth)

6110 OSTEOSARCOMAS, FIBROSARCOMAS, AND BASAL-CELL CARCINOMAS IN RABBITS AFTER IRRADIATION WITH GAMMA-RAYS OR FISSION NEUTRONS: AN INTERIM REPORT ON INCIDENCE, SITE OF TUMOURS, AND RBE. Hulse, E. V. (MRC Radiobiology Unit, Harwell, Eng.). Int. J. Radiat. Biol.; 16: 27-30(1969).

Osteosarcomas, fibrosarcomas and basal-cell carcinomas developed after whole-body neutron- or gamma-irradiation of rabbits, appearing sooner after neutron- than gamma-irradiation. Interim data suggest that the RBE for the production of all three types of malignant tumor combined is about 3. Nearly all the osteosarcomas were in the jaw, as in rabbits given ^{90}Sr. However, doses of only 1000–1600 rads of gamma-rays were required, much less than the accumulated dose reported for the corresponding ^{90}Sr-induced osteosarcomas. (auth) (UK)

6111 MEDICATION OF RADIATION ERYTHEMA. Hirabayashi, K.; Graham, J. (State Univ. of New York , Buffalo). Int. J. Radiat. Biol.; 16: 85-91(1969).

The mechanism of the vascular reaction following 1000 R x-irradiation through a small portal has been studied in mice skin. It was found that the vascular response appeared after a latent period of about 5 days and reaches a maximum on the twelth to fifteenth day. It is mediated by histamine released from mast cells. (UK)

6112 PROTECTION OF THE MOUSE AGAINST THE LETHAL ACTION OF LOW INTENSITY IONIZING RADIATIONS. Van Caneghem, P. (Univ., Liege). Int. J. Radiat. Biol.; 16: 51-5(1969). (In French).

Mice fed on a diet containing 0.5, 0.25 and 0.125 per cent cystamine 2HCl are exposed to gamma-rays from a ^{137}Cs source at outputs of 10, 1, and 0.07 R/min. The cystamine does not show the unfavourable effect on survival after 30 days observed at higher concentrations; but it does not protect the animals. Leaving them without food for 12 to 48 hours before irradiation diminishes their resistance to the radiation. (auth) (UK)

6113 SHORT TERM EFFECTS OF X-RADIATION ON GOITROGEN INDUCED GROWTH OF THE RAT THYROID. Philip, J. R.; Crooks, J.; Macgregor, A. G.; McIntosh, J. A. R. (Univ. Medical School, Aberdeen, Scotland). Brit. J. Cancer; 23: 524-35(Sep 1969).

The effects of x-radiation in the range 200–2500 rad on the goitrogenic response of the rat thyroid to methylthiouracil administration were studied. It was found that the number of follicular cells per unit volume remained constant irrespective of dose of radiation, time after radiation and time on methylthiouracil. Consequently the changes in thyroid gland weight could be equated with changes in the total follicular cell population of the thyroid. The behavior of the mean total follicular cell population followed a clear pattern in response to the graded doses of x-rays. The results suggested that in the dose range employed no immediate cell death occurred. Furthermore, the first division cycle of intact and damaged cells proceeded at the same rate with no significant mitotic death occurring in the latter. With increasing doses of x-rays, fewer cells divided fewer times. The fact the doses of x-rays (e.g. 1000 rad.) which left very few cells reproductively intact caused no significant cell death indicated that doses of radiation which do cause significant cell death indicated that doses of radiation which do cause significant cell death, will leave only an infinitely small proportion of cells reproductively intact. This means that a radiation partial thyroidectomy with homogeneous radiation is intrinsically impossible in the rat. The similarity of these results to those obtained with other mammalian cells provides justification for extrapolation of the above conclusions to the radiotherapeutics of thyrotoxicosis in man. (auth) (UK)

6114 REPARATIVE PROCESSES IN THE MUCOUS MEMBRANE OF THE SMALL INTESTINE IN LOCAL AND TOTAL IRRADIATION. Lebedeva, G. A. Med. Radiol.; 14: No. 10, 36-42(Oct 1969). (In Russian).

In experiments on dogs, rats, and mice, some features peculiar to the course of the pathological process in the epithelium of the small intestine following total body or local x irradiation in doses causing the development of the acute intestinal syndrome (1000 to 1100 R or 2311 to 5300 beR) were studied. It was found that in all three species of animals the cessation of cellular division in the intestinal epithelium is accompanied by increased sizes of mononuclear cells and the appearance of multinuclear cellular forms. A study in rats showed that the appearance of multinuclear cells is preceded by an augmented area of nuclei of mononuclear cells; between these two values there is a reverse relationship. One of the main routes of formation of multinuclear cells in the irradiated intestine is amitosis of nuclei of mononuclear cellular forms. Following local irradiation of the region of the stomach or exteriorized intestine reparative processes start again in the mucous membrane. They start from focal proliferation of the epithelium of crypts and are characterized by the appearance of an intermittent generation of cells which is replaced by usual cellular forms. (auth)

6115 ANIMAL EXPERIMENTS ON THE EFFECT OF LOW X-RAY DOSES ON THE CENTRAL NERVOUS SYSTEM AND RADIOPROTECTIVE TESTS ON DRUGS. Giordano, P. L.; Invernizzi, G. (Univ., Milan). Arzneim.-Forsch., 18: 1417-20 (Nov. 1968). (In German).

Histologic studies and electroencephalographic (EEG) changes were followed in the central nervous system of rabbits exposed to acute, low doses of x rays and treated, in some instances, with anti-inflammatory drugs. Low doses of x rays in the central nervous system cause diffuse perivascular edema and, as a secondary effect, vacuolation of neurons. The possibility of these drugs inhibiting the exudative changes was tested. In the animals pretreated with 9α-fluoro-11β,17α,21-trihydroxy-16β-methyl-1,4-pregnadiene-3,20-dione (β-methasone) or escin (Reparil) the changes in EEG and histologic findings were less severe and prolonged than in the control animals. These findings confirm the antiedema effect of Reparil. (BBB)

6116 WITHIN-STRAIN DIFFERENCE IN RADIATION SENSITIVITY IN THE RFM MOUSE. Spalding, J. F.; Popp, Diana M.; Popp, R. A. (Los Alamos Scientific Lab., N. Mex.). Radiat. Res., 40: 37-45(Oct. 1969).

Two sublines of mice from an inbred RFM colony were shown to have different sensitivities when exposed to continuous low dose-rate γ-ray exposure. The sublines, selected by H-2 testing into either H-2^f or H-2^k lines, appear to reveal the influence of a radiation resistance factor associated with or closely linked to the H-2 locus. (auth)

6117 LASER EFFECTS ON VITAL DENTAL PULPS. Stern, Ralph H.; Renger, H. Lee; Howell, Francis V. (Univ. of California, Los Angeles). Brit. Dent. J., 127: 26-8(July 1, 1969).

An experiment was conducted on 10 chimpanzee teeth in vivo which were exposed to laser energy densities that ranged from 60 to 250 joules per square centimeter (5 mm diameter spot size). The higher laser energy densities are sufficient, according to previous studies, to inhibit formation in vitro of incipient caries-like lesions (white spots). Within the limitations of the experiment pulp changes observed after laser exposure are limited and reversible. (auth)

6118 THE RATE OF DECAY OF THE DOSE EQUIVALENT OF RADIATION INDUCED SUB-LETHAL DAMAGE. Liversage, W. E. (Charing Cross Group of Hospitals, London). Cell Tissue Kinet.; 2: 269-76(Oct 1969).

Existing experimental data relating to the rate of recovery of the dose equivalent of sub-lethal damage are analyzed. A precise determination of the half-life of the dose equivalent is found to be impossible, but all the evidence reviewed suggests that it is of the order of 1 or 2 hr for mammalian systems irradiated at normal body temperature and that, in such systems, little error is produced in dosage calculations by assuming a value of 1.5 hr to be applicable, as originally suggested by Lajtha and Oliver. (auth)

6119 RADIOAUTOGRAPHIC STUDIES OF THE STEM CELL IN THE THYMUS OF THE IRRADIATED RAT. Everett, N. B.;

Tyler, Ruth W. (Univ. of Washington, Seattle). Cell Tissue Kinet.; 2: 347-62(Oct 1969).

Radioautographic evidence is presented that characterizes the marrow derived stem cell that promotes thymic recovery following irradiation in the rat. These immigrant cells are similar in morphology to blood monocytes and were called monocytoid, meaning monocyte-like in appearance. The typical cell had abundant pale staining cytoplasm and a nucleus with many invaginations and folds and a fine chromatin structure. There was no prominent nucleolus. The majority of these cells entered the thymus of the irradiated rat via the blood vessels into the septa and made their way through the connective tissue to the outer cortex. Three distinct morphological cell types appeared to be derived from the immigrant cells. These were fibrocyte-like cells that were located within the septa, macrophages located mainly within the medulla and septa, and large blast cells within the cortex, that proliferated giving rise to large thymocytes. The blast cells were characterized as having abundant moderately basophilic (and pyroninophilic) cytoplasm with a distinct cytoplasmic boundary, a large nucleus that still had invaginations and folds, a loose chromatin structure and one or more very prominent nucleoli. They were located in groups primarily within the outer cortex and often adjacent to blood vessels. They were found to be highly susceptible to damage in smear preparations. In contrast, their progeny, the large thymocytes, were not highly susceptible to damage in smear preparations but teased out as large round cells with a highly basophilic rim of cytoplasm. The large thymocytes were precursors to medium and small cells. A radioautographic technique for 1 μ tissue sections is also described. (auth)

6120 ANATOMIC STUDIES OF THE DISTRIBUTION AND EFFECTS OF INTRATHECAL RADIOACTIVE GOLD. Kieffer, Stephen A.; Stadlan, Emanuel M.; D'Angio, Giulio J. (Univ. of Minnesota, Minneapolis). Acta Radiol., Ther., Phys., Biol.; 8: No. 1-2, 27-37(Feb-Apr 1969).

Laboratory studies in 19 dogs given ^{198}Au intraventricularly and followed for periods up to 18 months have demonstrated a leptomeningeal vascular reaction but no parenchymatous degeneration. Similar but generally less marked changes were found in 12 dogs given an identical volume of what was, for practical purposes, a non-radioactive colloidal gold preparation. The lack of damage to the brain and spinal cord parenchyma has encouraged the use of intrathecal radiogold in a clinical regimen for treatment of such neoplasms as the medulloblastoma and the ependymoma. (auth)

6121 EFFECT OF IONIZING RADIATION ON THE ERYTHROCYTE AND RETICULOCYTE METABOLISM. Ababei, L.; Filip, M.; Haller, C.; Moisiu, M. (Institut Cercetari Medicale Filiala Academiei, Iasi). Folia Haematol. (Leipzig), 90: 149-55 (1968). (In German).

Rabbits received whole-body doses of x radiation up to 900 R. Various properties of erythrocytes and reticulocytes were studied, such as metabolism and membrane permeability, as well as the protective action of cystamine. (H.B.G.)

6122 HEMOPOIESIS IN CHIMERAS. Zaretzkaya, Ya.; Kovalchouk, L.; Kvasnikova, L. (Inst. of Biophysics, Moscow). Rev. Fr. Etud. Clin. Biol., 14: 590-4(June-July 1969). (In French).

Hemopoiesis was studied in CBA mice that were γ-irradiated at a lethal dose and received isogeneic or xenogeneic bone tumor cells. Chimeras were sacrificed from the fifth to the 100th day after the irradiation. The myeloid, lymphoid, and erythroid cells from the spleen, femur, and axillary lymph nodes were counted at regular intervals. A characteristic of hemopoiesis in the xenogeneic chimeras was the lymphoid deficiency. The following conclusions were drawn: The principal cause of death in the xenogeneic chimeras protected by bone tumor was the lymphoid atrophy that was not compensated for by the donor's bone marrow. This lymphoid atrophy was maintained by a graft v host reaction (and perhaps by a host v graft reaction). (auth)

6123 POSTIRRADIATION AVOIDANCE AND RECOVERY OF PREFERENCE OF SACCHARIN SODIUM IN MICE. Moos, W. S.; LeVan, H.; Klauser, R. (Univ. of Illinois, Chicago). Med. Exp., 18: 45-54(1968).

Previous behavioral investigations on the radiation-induced motivation involving a conditioned avoidance of a distinctive taste substance by irradiated animals are discussed. Saccharin is usually offered to the mice simultaneously with plain tap water prior to, during, or after the animals are exposed to radiation. X-ray-conditioned saccharin aversion of mice during the post-irradiation period starts shortly after the water-saccharin preference test is initiated immediately following irradiation. In the present report, observations were recorded over 8 weeks following the exposure of mice to x rays during which the gradual recovery of saccharin preference was noticed. In the first experiment the mice were offered a choice of saccharin solution and tap water; in the second, only saccharin sodium was given before and after irradiation. The results indicated that saccharin aversion was greatest and recovery slowest in the group that was offered saccharin alone just before irradiation. The saccharin + water group showed also a considerable decrease in the amount of postirradiation saccharin intake, but the recovery of saccharin preference was much faster than the saccharin group. The reduction of saccharin intake was not very significant in the water and no-liquid groups. In tests where there was no other choice of liquids given, the postexposure aversion of saccharin was smaller and the recovery about 50% faster. Nevertheless, in both cases the total recovery was not completed during 8 weeks after irradiation. Water consumption for the saccharin group increased while in the other 3 groups it remained almost unchanged. Post-irradiation total liquid consumption dropped significantly for the saccharin and saccharin + water group, while the total intake of the water group and no-liquid group was not altered. (BBB)

6124 MICRORADIOGRAPHIC FEATURES OF RAT DENTIN FORMED DURING AND FOLLOWING IRRADIATION. Adkins, K. F. (Dental Coll., Brisbane). Arch. Oral Biol., 13: 289-95 (Mar. 1968).

The effects produced in dentin by 1 × 1200 R, 2 × 600 R, and 4 × 300 R of x radiation were studied by microradiography. The intravital fluorochromes, alizarin red S, and tetracycline hydrochloride, were injected to label the pretreatment, treatment, and post-treatment periods chronologically. The calciotraumatic lines caused by the tetracycline injections allowed recognition of the 3 periods in the microradiographs. In the 1 × 1200 R animals the pretreatment and treatment zones were comparable, as expected since no treatment was given to these animals, apart from the tetracycline injections, until day 32. From day 32 onwards the dentin differed markedly from the earlier zones in the same specimens and from the corresponding zones in control specimens. The post-treatment dentin was distinctly radiolucent. The calciotraumatic lines representing day 29 in the 2 × 600 R radiographs were broader and more diffuse than the corresponding lines in the control and 1 × 1200 R specimens. Presumably this was because there were two treatments administered to the 2 × 600 R animals on day 29 (irradiation followed by injection). From day 32 onwards the dentin was distinctly radiolucent and appeared comparable to the post-treatment zones in the 1 × 1200 R specimens. When radiation was administered daily as in the 4 × 300 R animals, the calciotraumatic effect was much more sustained. The dentin formed during and following irradiation was uniformly radiolucent. Thus, on the days on which the rats were irradiated the dentin formed was hypomineralized even when the daily dose was as low as 300 R. Following the completion of irradiation, the dentin formed was hypomineralized in every irradiated animal. (BBB)

6125 RECONSTITUTION OF THE EXTERNAL GRANULAR LAYER OF THE CEREBELLAR CORTEX IN INFANT RATS AFTER LOW-LEVEL X IRRADIATION. Altman, Joseph; Anderson, William J.; Wright, Kenneth A. (Purdue Univ., Lafayette, Ind.). Anat. Rec., 163: 453-72(Mar. 1969).

The heads of 3-day-old rats were irradiated with a single dose of 200 R, and the animals were killed at intervals of from 10 min to 5 days. Necrosis in the external granular layer of the cerebellum was evident by the fourth hour and the pyknotic cells increased in number up to 12 hr after irradiation. Between 24 to 48 hr all the pyknotic cells disappeared and the width of the layer was drastically reduced. By the third day after irradiation the external granular layer began to increase in width and by the fourth day it was indistinguishable from normal. In adults of this group the cerebellum appeared structurally normal. In another experiment the cerebellum of rats was exposed from birth onward to 200 R on 5 successive days. In the animals killed immediately or 1 day after the last radiation session the external granular layer was totally or subtotally eradicated. In the animals surviving for 4 days the external granular layer reappeared over many regions of the cerebellum, and by the sixth day after irradiation it was present over its entire surface. In these animals that survived to 30 and 90 days of age the cerebellum contained a large, though subnormal, population of granule cells, indicating that the reconstituted cells were able to differentiate. These results suggest that the proliferative matrix of the postnatally developing cerebellum may be endowed with regenerative capacity. (BBB)

6126 EXPERIMENTS WITH TISSUE CULTIVATION IN VIVO FOR THE STUDY OF THE REGENERATIVE CAPACITY OF THE SPLEEN FOLLOWING EXPOSURE TO RADIATION. Georgiev, I.;

Colakov, Hr. (Higher Medical Inst., Plovdiv, Bulgaria). Folia Med. (Plovdiv), 9: 71-8(1967). (In German).

Effects on regenerative capacity of x-irradiated rat spleen tissue implanted in chambers within the abdomens of unirradiated rats were studied. Irradiation doses ranged from 1500 to 10,000 R. When the cultures were studied histologically 5 days later, no differences were observed in spleen tissue irradiated with doses of 1500 or 2000 R. Compared to unirradiated spleen cultures, spleen cultures irradiated with 5000 R showed a very markedly necrotic central zone and the fibroblast capsule was relatively undeveloped. The growth zone was small, and many degenerative reticular cells were observed. The spleen cultures irradiated with 10,000 R showed marked cell destruction, with only pigment-filled reticulum cells present. Some of these were vacuolated and hypertrophied. There was a growth zone, but containing only a thin fibroblast layer with a few mitoses and large round basophilic cells that resembled plasmocytes. After 10 days the proliferation zone was enlarged, and a reactive capsule had started to form, with a growth zone of multinucleated giant cells. (BBB)

6127 THE EFFECT OF PORTACAVAL TRANSPOSITION ON RADIATION NEPHRITIS-INDUCED HYPERTENSION IN THE DOG. Schwartz, David T.; Alpert, Meyer; Sommers, Sheldon C.; Mason, Richard C. (Columbia Univ., New York). Lab. Invest.; 21: 426-33(Nov 1969).

Transposition of the hepatic portal vein and inferior vena cava above the kidneys prevents and reverses hypertension caused by unilateral renal artery stenosis or unilateral experimental arteriolar nephrosclerosis. These lesions are believed to maintain or initiate hypertension by a greatly increased release of renin in response to renal ischemia. In order to test the effects of portacaval transposition on hypertension resulting from a predominantly interstitial lesion, radiation nephritis was produced in 20 dogs by a single dose of 1000 R x radiation to the left kidney. Of the 17 surviving animals, six had portacaval transposition prior to irradiation, six after irradiation, and five served as controls. None of the six dogs with portacaval transposition before irradiation developed hypertension, whereas all animals without transposition became hypertensive. The blood pressures of the six animals shunted after the development of radiation nephritis returned to normal. All irradiated kidneys were atrophic and showed marked interstitial fibrosis, whereas arteriolar medial hypertrophy was present only among animals which had been hypertensive. Juxtaglomerular cell counts were below normal in hypertensive animals but were normal in animals that had remained normotensive. The results suggested that radiation nephritis-induced hypertension was not dependent on juxtaglomerular hyperactivity and could be reversed and prevented by portacaval transposition. (auth)

6128 MORPHOLOGICAL AND HEMATOLOGICAL CHANGES IN THE DEVELOPMENT OF SECONDARY DISEASE IN ALLOGENOUS RADIATION CHIMERA: MICE. Butomo, N. V.; Zaitseva, K. K. (Military Medical Academy, Leningrad). Arkh. Patol.; 31: No. 9, 31-5(1969). (In Russian).

A comparison was made of the results of pathomorphological and hematological study of mice of the CC57W strain sacrificed 5 weeks after irradiation and transplantation of the allogenous, xenogenous or syngenous bone marrow. Analysis of the changes revealed demonstrated that they were the sequence of both the sustained radiation injury and the development of tissue incompatibility reactions. The most characteristic for the development of secondary disease were deep atrophy of lymphoid tissues in the absence of any signs of lymphopoiesis regeneration, cellular polymorphism of lymphoid follicles, marked focal hyperplasia of the red pulp of the spleen and of the bone marrow tissue, systemic hyperplasia of reticulo-endothelium, pronounced anemia and hyperneutrophilosis. (auth)

Man

Refer also to abstracts 6022, 6026, 6054, 6064, 6088, 6097, and 6098.

6129 ELEMENTARY THEORY LEADING TO NON-LINEAR DOSE RISK RELATIONSHIPS FOR RADIATION CARCINOGENESIS. Wright, J. K.; Peto, R. (Berkeley Nuclear Labs., Eng.). Brit. J. Cancer; 23: 547-53(Sep 1969).

The consequences were analyzed of a two stage theory of carcinogenesis in which inhibition breaks down if it so happens that the pattern of activated cells contains a small closely grouped cluster of such cells. It was shown that this may lead to a nonlinear dose-risk relationship. A more specific but still fairly general model was then discussed in which it was assumed that growth is resisted by a diffusing inhibiting substance, and a power dose-risk relationship is demonstrated. If such non-linearities were confirmed there would be important implications to the judgment of permissible radiation doses. (auth) (UK)

6130 MORPHOLOGICAL CHANGES IN THE TUMOR OF THE DISTAL REGION AFTER BREMSSTRAHLUNG IRRADIATION. Savchenko, E. D.; Garvei, N. N.; Barkanov, A. I.; Kornev, I. I. Med. Radiol.; 14: No. 10, 31-5(Oct 1969). (In Russian).

Combined radiotherapy and surgical treatment was used for 25 patients with cancer of the distal portion of the stomach. Seventeen were radically operated after x irradiation at doses of 2000 to 4000 rad. Under the influence of the referred to doses, and in intervals between irradiation and operation of two weeks, the morphological changes in the tumor were in most cases more marked than during the first week. Thus, in cancerous cells there was seen granular and fatty degeneration, vacuolization of the protoplasm and nucleus, and sometimes pyknosis. Degenerative processes in the neoplastic cells were attended by reduction of their mitotic activity. Along with foci of necrosis and necrobiosis, there were also noted areas of infiltrative growth of the tumor with the presence of hyperchromic nuclei in its cells and a significant number of mitoses therein. If the interval between irradiation and operation reached 3 to 4 weeks the field of active neoplastic growth increased, notwithstanding the presence of marked degenerative processes in the tumorous tissue. Thus, these data confirm the expediency of an earlier course of operative intervention in patients with cancer of the distal portion of the stomach, subjected to preoperative irradiation (doses of 2000 to 4000 rad). (auth)

6131 MEASUREMENT OF THE VOLUME OF CIRCULATING BLOOD IN RADIOIODINE TREATMENT OF THYROTOXICOSIS. Chebotareva, E. D.; Shishkina, V. V.; Markova, O. P. (Kharkov Research Inst. of Medical Radiology). Med. Radiol.; 14: No. 10, 12-18(Oct 1969). (In Russian).

The volume of circulating blood, mass of circulating erythrocytes, and volume of circulating plasma was measured in 68 patients with thyrotoxicosis before and after ^{131}I treatment. It was established that after radioiodine therapy the number of patients with anemia of diverse severity significantly decreased (from 72% before treatment to 42% after treatment). In 13% of patients there was noted an intensification of anemia. The decrease of indices of the circulating erythrocytes noted in a number of cases was associated with dysfunction of the thyroid gland observed 3 to 4 months after radioiodine therapy. At later periods (in 9 to 24 months) the red blood indices normalized. (auth)

6132 MICROWAVE HAZARDS EVALUATION: CONCEPTS AND CRITERIA. Michaelson, Sol M. (Univ. of Rochester, N. Y.). J. Microwave Power; 4: 114-19(1969). (UR-49-1071).

A basis for evaluating the microwave effects data obtained on experimental animals and from surveys on humans is presented. Nonthermal effects of microwaves and comments on the Soviet views are also considered. (auth)

6133 CAPILLARY BLOOD CIRCULATION OF NONIRRADIATED SKIN IN RADIATION THERAPY OF CANCER OF THE UTERUS. Tsilyurik, I. T.; Baronina, L. A. Med. Radiol., 14: No. 6, 77-8(June 1969). (In Russian).

The fourth finger of the left hand was studied on a capillaroscope in 60 patients with uterine cancer before and after irradiation with therapeutic doses of 1700, 3300, and 6700 Rads. A lowering of arterial pressure was noted in 44 patients. The blood color remained unchanged in 33 patients, and became paler in 24 patients. Homogeneous blood flow was observed before radiation therapy. The character of the blood flow did not change in 35 patients, became grainy in nine patients, and slowed down in 16 patients after irradiation at 3300 and 6700 Rads. This behavior indicates an increased penetrability of the vascular wall. The radiation therapy was frequently accompanied by a decrease in the elasticity of the arterial wall, as indicated by an increase in outflow time and a slight increase in time of inflow. The flow of blood through the capillaries was hindered, as indicated by an increase in pressure difference at the filling point and the circulation point observed in 28 patients. A sharp drop in capillary flow was noted in 36 patients. Thus, a decrease in capillary blood-filling and increasing hypotony of the vascular system was observed with increasing dose. These disturbances of the capillary circulation indicate a general vascular response of the organism to irradiation. (TTT)

6134 HEMATOLOGICAL ASPECTS OF RADIUM THERAPY. Dvoretskii, L. I. (Inst. of Biophysics, Moscow). Med. Radiol., 14: No. 6, 58-64(June 1969). (In Russian).

The effect of therapeutic radiation on hematopoietic tissue is of interest because of the high radiosensitivity of the blood-forming tissue. This review analyzes the results of morphological and functional studies of bone marrow after radiation therapy, and touches on the clinical significance of leukopenia which de-

velops after irradiation. A decrease in normoblasts is observed at doses of 175 to 300 R with a gradual tendency of hypoplasia of the bone marrow on increasing the local dose to 3000 R. Disturbances in cell division, the appearance of gigantic forms, and the beginning of a decrease in cellular elements take place at a dose of 1000 R. A single chest dose of 28 R leads to a high percent of lymphocytes and neutrophils with segmented nuclei. A single 500 R dose decreased the cell content in the bone marrow by 40%, and markedly decreased the number of myeloblasts and cells in a state of division. These typical therapeutic doses lead to atypical figures of mitoses indicating a disturbance in cell division. In 47 of 58 Japanese patients receiving radiation therapy, the bone marrow was hypo- or aplastic in the irradiated tissue while only six patients showed hypoplasia in the nonirradiated parts of the hematopoietic system. About 20 to 25% of the bone marrow is involved in the radiation treatment of a cancerous tumor. Thus in spite of the presence of leukopenia the bone marrow from unirradiated parts of the body may contain a sufficient number of normal cells. A purified bacterial lipopolysaccharide (Pirexal) which elicits a neutrophil leukocytic reaction is used to test the functional state of the bone marrow. The danger of leukopenia is minimal on limiting the width of the radiation field. Leukopenia is encountered most often on irradiating the stomach, and then the chest, head and extremities. In itself leukopenia during radiation therapy is caused mainly by lymphopenia and is not a serious danger to the patient, since the main mass of unirradiated bone marrow is intact. (TTT)

6135 EFFECTS OF THORACIC IRRADIATION ON PULMONARY ARTERIAL PERFUSION IN MAN. Goldman, Stanford M.; Freeman, Leonard M.; Ghossein, Nemetallah A.; Sanfilippo, Louis J. (Albert Einstein Coll. of Medicine, New York. Yeshiva Univ., New York. Bronx Municipal Hospital Center, New York). Radiology, 93: 289-96(Aug. 1969).

Seventy-six patients who received pulmonary radiation for primary or metastatic lung neoplasms or as incidental irradiation for extrapulmonary lesions were studied by means of lung scans and chest roentgenography before, during, and following treatment. Forty per cent of the hilar lesions produced extensive impairment in perfusion out of proportion to the size of the tumor as noted on the roentgenogram. Within six weeks following radiotherapy, arterial perfusion was restored to the lung made ischemic by neoplasm in a significant number of patients (45.6%). The lung scan and the chest roentgenogram are of equal value in detecting early changes of radiation pneumonitis and should be used in a complementary manner. The area of radiation-induced ischemia noted on the scan was larger than the fibrotic changes seen on the roentgenogram in patients who had a long-term follow-up. The hemithorax scan was of value in studying markedly underperfused lungs in 9 of 14 patients in whom it was employed. (auth)

6136 ROENTGEN SENSITIVITY OF CEREBRAL TUMORS AND SO-CALLED LATE IRRADIATION NECROSIS OF THE BRAIN. Zuelch, K. J. (Max-Planck-Institut fuer Hirnforschung, Cologne). Acta Radiol., Ther., Phys., Biol.: 8: No. 1-2, 92-110(Feb-Apr 1969).

The effects of conventional irradiation on different types of intracranial tumors are described and indications for radiotherapy are given on the basis of morphological observations. The possibilities of late irradiation damage to the brain and spinal cord are emphasized; such damage may suggest either recurrence or give a false impression of cure. In the absence of correlation with autopsy and isotope data and operative and angiographic findings, these facts should be taken into account in all statistical evaluations of the results of irradiation therapy. (auth)

6137 ON THE SIGNIFICANCE OF THE ROENTGEN DOSAGE APPLIED IN A UNIT OF TIME IN DERMATOLOGIC RADIOTHERAPY. Lozeron, H.; Maggiora, A.; Rossier, J.; Jadassohn, W. (Univ., Geneva). Dermatol. Wochenschr., 154: 537-40 (June 8, 1968). (In German).

Within twelve seconds to four minutes the same total doses of x radiation were administered at various dose rates to roots of Vicia faba equina, to the abdominal skin of guinea pigs, and to the skin of human patients. In most cases, the higher dose rate caused a more severe biologic reaction. (H.B.G.)

6138 LARYNGEAL CHONDROSARCOMA AFTER THYROID IRRADIATION. Ghalib, Sami H.; Warner, Emory D.; DeGowin, Elmer L. (Univ. of Iowa, Iowa City). J. Amer. Med. Ass.: 210: 1762-3(1 Dec 1969).

A fatal primary chondrosarcoma of the laryngeal cartilages is reported. The patient, a 74-yr-old woman, had received x irradiation of the neck 40 yr previously for hyperthyroidism. Metastasis of the tumor brought on vascular occlusion and acute tracheobronchitis causing respiratory compromise and ultimately death. The x irradiation of the thyroid region previously received by the patient was sufficient to cause such a condition. (E.R.B.)

6139 RADIATION INJURIES OF THE FACE. Mehrotra, M. C. (Neyveli Lignite Corp. Ltd., Madras). J. Indian Dent. Ass.; 39: 43-5(May 1967).

Injuries caused by inadvertent ionizing irradiation of structures of the oral cavity were discussed briefly. In the skin erythema was the first visible reaction and began within a few days after irradiation, faded quickly, and reappeared within 2 to 4 weeks. The secondary erythema faded slowly, often leaving the skin permanently pigmented as a light tan shade. After heavy irradiation the secondary erythema was accompanied by edema with desquamation of epithelial cells, resulting in denudation of the surface. Reepithelization occurred in 10 to 14 days. Secretion of the sebaceous and sweat glands was reduced with dryness and scaling of the skin within a week after the start of irradiation. Epilation was produced either temporarily or permanently, because of destruction of the hair follicles. In the oral mucosa irradiation changes are practically the same as those of the skin. Xerostomia occurred within 2 weeks after the beginning of irradiation. Salivation returned gradually only after many months or there was permanent loss of secretion. The most common dental injury was radiation caries which often began at the cervical areas of the teeth. The lesion resembled demineralization rather than true caries. Bone itself was resistant to radiation although osteoblasts were sensitive. Intense irradiation disturbed the normal balance between bone formation and bone resorption. General bone vitality decreased and localized osteoporosis resulted. Irradiated bone was unable to react in the normal fashion to infection, because of damage to the vascular bed with disturbance of the typical inflammatory response. When irradiation shortly followed tooth extraction, the healing response was poor and slow. As the interval between tooth extraction and radiation was increased, impairment of healing was decreased. It was concluded that no radiotherapy should be attempted for 7 to 10 days following extractions in the mandible or for 6 days in the maxilla. The mandible was affected by osteoradionecrosis far more frequently than the maxilla. Sequestration eventually occurred after several months or years, but the patient usually suffered intense pain until then. The occurrence of osteoradionecrosis is unpredictable and it may arise even without gross infection or trauma. Of a series of 1810 patients with intraoral carcinoma or allied diseases treated with radiation, 13% had osteoradionecrosis. Of these 5% died from this disease without evidence of their original cancer. (TSS) (BBB)

Radiation Effects on Plants

Refer also to abstracts 5684, 6021, 6027, 6137, and 6145.

6140 STUDY OF CHEMICAL MODIFICATION OF RADIATION DAMAGE OF PLANTS DURING EXPOSURE TO FAST NEUTRONS. Grodzinskii, D. M.; Petrov, A. A. Kosm. Biol. Med.; 3: No. 5, 48-55(Sep-Oct 1969). (In Russian).

Using chemical substances, it was found possible to modify radiation damage in peas during irradiation of seeds with fast neutrons at a dose of D_{37}. As such substances catalase, DNA hydrolysate, cysteine, kinetin in combination with heteroauxin and hydroxylamine were used. The protective effect of chemical substances was assayed by means of a new formula which made it possible to correct the degree of restoration produced by the radioprotectors, taking into account their effect on an unirradiated organism. (auth)

6141 THE EFFECT OF LOW DOSES OF GAMMA RAYS UPON THE RATE OF INFECTION OF PLANTS WITH GRASS MILDEW [ERYSIPHE GRAMINIS DC]. Starzycki, S.; Pala, J.; Konopko, E. (Plant Breeding and Acclimatization Inst., Radzikow, Poland). Hodowla Rosl., Aklim. Nasien.; 1: 103-8(1967). (In Polish).

Preliminary investigations were conducted to determine the effect of low doses of γ radiation on the rate of infection of barley variety Browarny PZHR by grass mildew (Erysiphe graminis). The following doses of γ radiation were applied: 300, 500, 700, 1000 R, and a check combination to null. The experiments were conducted under glasshouse conditions. Barley seedlings were infected by direct contact at the stage of second leaf. Measurements, performed in nine days following infection, showed some differences in the rate of infecting plants, according to the radiation dose applied. Results indicate that under optimum conditions of the experiment a low dose of γ radiation had some beneficial effect upon the rate of infection with grass mildew. The most significant difference was noted at 500 R where the number of noninfected plants was maximum, yet the number of plants infected to the highest degree was almost null. Results of the experiment are

promising for practical breeding, however, because of the scope of the work one should not draw final conclusions. (NSA of Poland)

6142 EFFECT OF THE RESTORATION PROCESSES MAKE IT POSSIBLE TO DISTINGUISH ACUTE AND SUBACUTE IRRADIATIONS IN CHLORELLA. Gilet, Roland; Terrier, Jacques (CEN, Grenoble, France). Compt. Rend., Ser. D, 269: 383-5 (July 21, 1969). (In French).

The restoration processes are inhibited at 0°C in Chlorella pyrenoidosa exposed to ^{60}Co gamma radiation. From survival curves at various temperatures and dose rates, hypothesis and mathematical formulations for biological radiation effects and reparative processes were derived. (H.B.G.)

6143 EFFECT OF VARYING UV INTENSITIES ON THE CONCENTRATION OF SCOPOLIN AND CAFFEOYLQUINIC ACIDS IN TOBACCO AND SUNFLOWER. Koeppe, D. E. (Univ. of Illinois, Urbana); Rohrbaugh, L. M.; Wender, S. H. Phytochemistry, 8: 889-96(May 1969).

The effect of uv irradiation (GE germicidal lamp No. G30T8, emitting mainly 2537 Å radiation) on the levels of several compounds in tobacco and sunflower was measured. One-dimensional paper chromatography was used for quantitative determination of chlorogenic acid, neochlorogenic acid, 4-O-caffeoylquinic acid ("band 510"), and scopolin. With high uv intensity, an increase in scopolin concentration was found in tobacco leaves and stems and in sunflower leaves. Chlorogenic acid concentration was higher in roots, stems, and leaves of tobacco plants treated with low uv doses than in comparable plants grown under control or under high-dose uv conditions. Chlorogenic acid concentration of sunflower leaves was less under low uv radiation than in comparable sunflower plants of control or of higher uv treatments. In stems and roots of sunflower, no consistent pattern of change in the chlorogenic acid concentration was found under the uv conditions tested. (BBB)

6144 RADIOBIOLOGICAL MEASUREMENTS WITH 14 MeV NEUTRONS. Hall, E. J. (Churchill Hospital, Oxford). Brit. J. Radiol.; 42: 805-13(Nov 1969).

Two test systems, the inhibition of root growth in Vicia seedlings and the survival of Chinese hamster cells, were used to investigate the radiobiological properties of 14 MeV D-T neutrons compared with 250 kVP x rays. For Vicia, the oxygen enhancement ratio for neutrons was 1.66, compared with 2.67 for x rays. The neutron OER was not changed if the seedlings were irradiated at 19 cm deep in a water phantom using an uncollimated neutron beam. Over a range of doses from 19.4 to 72 rads, the relative biological effectiveness of neutrons compared with x rays was found to decrease with increasing dose from 5.6 to 3.5. For Chinese hamster cells the neutron OER was approximately 1.5 compared with 2.67 for x rays. At the higher dose levels required for this test system, the relative biological effectiveness of neutrons compared with x rays was about 1.5. Using both Vicia seedlings and hamster cells synchronised with hydroxyurea, the response to a single dose was studied as a function of the stage of the mitotic cycle at which the radiation was delivered. The pattern of response was similar for both x rays and neutrons, with a maximum resistance during the DNA synthetic period, and a maximum radiosensitivity at, or just prior to, mitosis. (auth) (UK)

Radiation Effects on Microorganisms

Refer also to abstracts 5684, 6028, and 6158.

6145 (RLO-1952-3) MECHANISM OF PHOTOREACTIVATION OF PLANT VIRUSES. Final Report. ([Montana State Univ., Missoula]). [1968]. Contract AT(45-1)-1952. 6p. Dep. CFSTI.

The relation of particle morphology and nucleic acid metabolism to the photoreactivation (PR) of plant viruses was studied. The experiments concerning particle morphology confirmed previous reports that rigid, rod-like virus particles were non-photoreactivable, while the flexible, thread-like particles did demonstrate PR of uv-radiation damage. In experiments designed to demonstrate the effects of kinetin (promotes RNA synthesis in plants) and actinomycin D (inhibits DNA-dependent RNA synthesis) on PR of RNA systems (plant viruses), it was shown that kinetin inhibited susceptibility of uv-irradiated leaves of Nicotiana glutinosa to tobacco mosaic virus (TMV), while actinomycin D promoted susceptibility at low concentrations, but decreased susceptibility at high concentrations. The temperature coefficient of PR was studied using clover yellow mosaic virus (CYMV) and a temperature range of 15.5 to 26.6°C. No consistent effect of temperature on PR was noted. Efforts to render a non-photoreactivable virus—TMV—photoreactivable were undertaken using certain bond-loosening agents including urea, low temperature, and high pH. Results indicated that 2M urea did render TMV photoreactivable, as was true for a few experiments where the virus was irradiated at 6°C. Results of the high pH experiments were negative. The possibility that photoprotection (PP) rather than PR was responsible for the apparent reversals of uv-damage in plant tissues was also studied. When uv-irradiated tobacco leaf discs were exposed to fluorescent light through clear plastic or Mylar films, essentially no damage was observed where the clear plastic was used, but only slight PR was obtained with the Mylar filter. Since Mylar permits the passage of visible light wavelengths only, filtering out the near-uv wavelengths effective in PP, a PP mechanism is indicated. Using a Gomphrena globosa—CYMV system, host plants were exposed to fluorescent light through clear plastic or Mylar filters following inoculation with uv-irradiated virus. No PR was noted in the Mylar-filtered group. Since PP can be induced by light exposure after uv irradiation, these results are also compatible with the existence of a PP mechanism. In subsequent experiments related to the earlier kinetin experiments, the uv-radioprotective effect of kinetin on tobacco leaves was demonstrated. Proposed studies of PR in vitro were abandoned because of the low in vivo values for PR of the infectious nucleic acid of TMV that was to be used. (E.R.B.)

6146 TEMPERATURE DEPENDENCE OF RADIATION SENSITIVITY IN THE DRY STATE: A MODEL DERIVED FROM EXPERIMENTS USING ATOMIC HYDROGEN. Kuerzinger, K. (Institut fuer Strahlenbiologie, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 16: 1-13(1969).

The effect of temperature on the inactivation rate of phage T1 in vacuo by radiation-induced diffusible radicals has been studied. Reactive species were liberated by 2-MeV protons impinging on thin foils of organic material and permitted to reach phage samples arranged at some distance. Thus, the sites of radical production and radical reaction were separated in space. Two different modes of exposure were used: the temperature either of phage samples only (method A), or both of foil and samples (method B), could be varied from 100°K to 340°K. Activation energies of 0.65 ± 0.1 kcal/mole and 0.95 ± 0.1 kcal/mole, respectively, were derived from the temperature dependence of damage. The latter value, simulating inactivation by secondary processes in ionizing radiation, strongly supports the hypothesis that the activation energy of 1 kcal/mole frequently reported in the literature for radiation damage, is related to H radical action. Using the results of both experiments, an interpretation of the temperature effect is given by separating the overall activation energy into components of 0.3 kcal/mole necessary for H atoms to overcome cage-effects at the parent-molecule and of 0.65 kcal/mole to maintain diffusion by freeing the radicals from trapping sites. (auth) (UK)

6147 PROTEIN SYNTHESIS IN ESCHERICHIA COLI AFTER GAMMA-IRRADIATION IN THE PRESENCE OF ALKALI HALIDES. Keneko, I. (Inst. of Physical and Chemical Research, Saitama, Japan). Int. J. Radiat. Biol.; 16: 79-83(1969).

The results clearly indicated that gamma-irradiation in the presence of alkali halides inhibits amino-acid incorporation into protein in Escherichia coli. High concentrations of alkali halide itself showed some effect on protein synthesis. The results supported the theory that the sensitive synthesizing capacity might be related to cellular recovery mechanisms. (UK)

6148 FURTHER STUDIES ON THE INACTIVATION OF THE SCRAPIE AGENT BY ULTRAVIOLET LIGHT. Haig, D. A.; Clarke, M. C.; Blum, E.; Alper, T. (Agricultural Research Council, Compton, Eng.). J. Gen. Virol.; 5: 455-7(Oct 1969).

Two different suspensions containing the infective agent of scrapie were irradiated on 2 days separated by a week and were exposed to nearly, monochromatic U.V. at 254 nm from a 15W germicidal lamp. All of the samples were assayed in duplicate and about the same level of activity remained after similar doses in both experiments. Ultraviolet absorption spectra taken on several preparations made at various times, were constant within fairly narrow limits. From the inactivation curve (fitted by eye) the incident U.V. dose required to give an average of one lethal event per infective unit (i.e. the dose to give e^{-1} or 36.8% of the control activity) was 2.4×10^5 ergs/mm^2. Doses of that order are much greater than are required to inactivate viruses or transforming DNA. (UK)

6149 KINETICS OF ENZYMATIC PHOTOREACTIVATION STUDIED WITH PHAGE T1 AND ESCHERICHIA COLI B_{s-1}. Muraoka, Noriko; Kondo, Sohei (Osaka Univ.). Photochem. Photobiol.; 10: 295-308(1969).

The kinetics of enzymatic photoreactivation (PR) of uv-induced killing was compared among E. coli B_{s-1}, phage T1 in B_{s-1}, and phage T1 in irradiated B_{s-1}. The PR action spectrum showed no

substantial difference between PR of $B_s{-}1$ and PR of Tl in $B_s{-}1$. The PR D_{37} (i.e. the PR dose required to reactivate all but 37 per cent of the reactivable lethal lesions) was found to decrease linearly with decreasing uv dose whether uv was given to produce pyrimidine dimers in $B_s{-}1$ DNA, which then compete with irradiated Tl DNA for PR enzyme, or to $B_s{-}1$ or Tl DNA to produce dimers serving as substrate for the PR enzyme. A generalized Michaelis–Menten formula was used to analyze the data and the following conclusions were drawn. The number of PR enzyme molecules per cell available for PR of Tl DNA inside the $B_s{-}1$ host is only a quarter of the number available for PR of the $B_s{-}1$ host itself. The Michaelis constant K_m for reaction of host-DNA-damage and PR-enzyme becomes larger when the host damage acts as competitive inhibitor to PR of Tl DNA than when it is the substrate for PR enzyme. PR enzyme retains almost all its initial catalytic efficiency even after about two-hundred rounds of catalytic functioning. Conclusions (1) and (2) suggest that PR enzyme is concentrated within the nuclear area surrounding the host DNA. (auth) (UK)

6150 THE INDIRECT ACTION OF γ-RAYS ON THE COAT PROTEIN OF BACTERIOPHAGE PARTICLES. Luthjens, L. H.; Blok, Joh (Medical Biological Lab., Rijswijk, Netherlands). Int. J. Radiat. Biol.; 16: 101-11(1969).

Suspensions of bacteriophage T4 in 25 mM phosphate buffer, pH 7.1 were irradiated with ^{60}Co γ-rays. Measurements of the viscosity of irradiated samples before and after treatment with DNA-ase and trypsin showed that DNA is released from damaged phage particles. The phage debris acts as an effective radical scavenger and at higher doses protects the residual phage, thereby decreasing the inactivation rate. In irradiated suspensions of T4 and ΦX174 phage particles biologically-active subviral particles able to infect bacterial spheroplasts were found. Sedimentation in a sucrose gradient showed that the subviral particles of T4 have nearly the same sedimentation coefficient as unirradiated particles. Examination of irradiated samples with the electron microscope revealed that they contained many particles with the sheath contracted. The subviral particles produced by irradiation resemble those obtained with urea but do not show the tail clusters found in samples treated with urea. (auth) (UK)

6151 BACTERIOPHAGE-TAIL-LIKE PARTICLES ASSOCIATED WITH INTRASPECIES KILLING OF PROTEUS VULGARIS. Coetzee, Heleen L. (Univ. of Pretoria); de Klerk, H. C.; Coetzee, J. N.; Smit, J. A. J. Gen. Virol., 2: 29-36(1968).

Bacteriocinogeny was evaluated in 118 different strains of P. vulgaris. These and an additional 44 strains of P. vulgaris were used as indicators. Sixty-seven of the strains had a nontransmissible killing effect on one or more of the indicator organisms and 30 of these 67 bacteriocins with different spectra of activity were further investigated. Individual bacteriocins killed from 5 to 87 of the P. vulgaris indicators and a number of 44 different P. mirabilis strains, but had no action on strains of other species of the family Enterobacteriaceae. Both cultures of bacteriocinogenic strains were inducible by uv light and yielded bacteriocin titers of about $^1/_{100}$. The cultures were irradiated for 4 min with a 30-W Hanovia sterilamp (wavelength 2537 Å). Activity was sedimentable by high-speed centrifugation. Electron microscopy of all 30 preparations revealed similar phage-tail-like structures with a contractile sheath round a hollow core. The structures consisted of protein and did not contain DNA. The particles resembled some pyocins and also the tail of a P. vulgaris transducing phage. Bacteriocin activity was always associated with uncontracted sheaths, and triggered tails did not adsorb to susceptible organisms. The tail-like structures are the products of defective lysogeny. The high incidence of this state may be accounted for by the selection of genes favorable to the host that were originally acquired through transduction by lysogenization or lysogenic conversion. (BBB)

6152 REACTION OF AIRBORNE RHIZOBIUM MELILOTI TO SOME ENVIRONMENTAL FACTORS. Won, William D.; Ross, Harold (Univ. of California, Berkeley). Appl. Microbiol.; 18: 555-7(Oct 1969).

Survival of Rhizobium meliloti 102F5 in aerosols at 20°C was maximal at high relative humidity (RH) and minimal at low RH. Relatively high concentrations of NO_2, SO_2, or formaldehyde were needed to significantly reduce viability of R. meliloti in aerosols at 50% RH. Except for the reduction in activity of formaldehyde by SO_2, there was no additive or antagonistic effect of mixing pollutants. High environmental RH enhanced bactericidal activity of NO_2 and SO_2. High RH minimized and low RH accentuated the biological effect of ultraviolet light of 300 to 400 nm wavelength. (auth)

6153 REPAIR OF RADIOINDUCED DIMERS OF PYRIMIDINES IN DNA OF BACTERIOPHAGE λ: PARTICIPATION OF UVR AND REC GENES OF ESCHERICHIA COLI AND OF RED GENE OF λ. Radman, M.; Krsmanovic-Simic, D.; Errera, M. (Univ., Brussels). Arch. Int. Physiol. Biochim., 77: 397-9(May 1969). (In French).

Two mechanisms of repair of pyrimidine dimers formed in uv-irradiated DNA were studied: (1) excision of the dimers as controlled by the rec gene of Escherichia coli and (2) recombination repair controlled by the rec gene (the latter mechanism is, at present, only hypothetical). The repair of uv-induced dimers in phage λ DNA labeled with ^{14}C-2-thymidine was followed by radiochromatography. Survival curves of phage established eight possible combinations for the red, rec, and uvr genes. It was estimated that for each lethal hit there were 38 dimers in λ DNA in the red^+/rec^+uvr system, 7.2 dimers in the red^+/rec^+uvr^- system, 4 dimers in the red^+/rec^-uvr^+ system, and 2 dimers in the red^-/rec^-uvr^- system. It appeared that recombination, which is controlled by the rec and red genes can correct twice as many dimers in the λ genome than excision repair, controlled by the uvr genes. In the presence of the uvr system, the red gene can repair ~8 dimers, while in the absence of uvr only 2 dimers can be repaired by the red gene. The results reinforce the hypothesis that one molecule of DNA containing the pyrimidine dimers is repaired by excision before replication of the DNA and by recombination during or after replication. Repair by excision is most important after high doses of uv, which inhibit replication of DNA. (BBB)

6154 EFFECT OF REPEATED IRRADIATION ON VARIOUS CHARACTERISTICS OF SALMONELLA. Licciardello, J. J.; Nickerson, J. T. R.; Goldblith, S. A.; Bishop, W. W.; Shannon, C. A. (Massachusetts Inst. of Tech., Cambridge). Appl. Microbiol.; 18: 636-40(Oct 1969).

Four Salmonella serotypes which had been subjected to either 15 or 20 cycles of irradiation and subculture were examined for possible changes induced by the treatment. With three serotypes virulence remained unchanged, and with one serotype a reduction had occurred. A few minor changes in the biochemical characteristics occurred in some instances, but with all cultures the serological property was affected to some extent. Lag times and growth rates of the treated cultures were not altered, but the maximal viable population was usually less than that for untreated cultures. (auth)

6155 ON THE CHARACTERISTICS OF THE EFFECT OF HIGH ENERGY PROTONS ON BIOLOGICAL OBJECTS. Grigor'ev, Yu. G.; Ryzhov, N. I.; Derbeneva, N. N.; Popov, V. I.; Sychkov, M. A. Kosm. Biol. Med.; 3: No. 5, 38-43(Sep–Oct 1969). (In Russian).

Results of radiobiological studies performed during many years, using protons with the energy range of 660 to 10 MeV are reviewed. The synchrocyclotron of the Joint Institute of Nuclear Research was employed as the proton source. Radiations of 180 kV x-rays and ^{60}Co gamma-rays were used as standards. Analysis of the data obtained has shown that an exposure of animal organisms and microorganisms to high energy proton does not result in the development of principally new qualitative radiobiological effects typical of proton radiations only. However, reactions have been also recorded in which known symptoms of radiation disease develop in different quantitative proportions that can be interpreted as manifestations of qualitative variations. Study of the quantitative characteristics of the proton effect on biological objects has indicated that coefficients of the relative biological effectiveness of protons differ insignificantly, as their energy changes by more than one order of magnitude, from 660 to 50 MeV, amounting to 1 within this energy range. The RBE coefficients slightly increase, if the proton energy falls below 50 MeV. It should be noted that the similarity in the results has been found in a number of experiments conducted on a great variety of biological objects under various irradiation conditions (the experimental objects have been exposed to irradiation at different times of the day and season, at different doses and dose rates, ambient temperature, and oxygen partial pressure, etc.). This gives evidence that an RBE coefficient of 1 can be recommended for all cases of single acute exposures of animals and humans to 660 to 50 MeV protons during short-term space flights; the coefficient should be taken into consideration when designing shielding of space vehicles. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 5684, 5993, 6005, 6006, and 6008–6011.

6156 THE USE OF DRY-FREEZED BONE GRAFTS STERILIZED BY GAMMA RAYS IN ORTHOPEDIC SURGERY. Malaw-

ski, Stefan; Serafin, Jan (Kliniki Ortopedycznej, Warsaw). Chir. Narzadow Ruchu Ortoped. Pol., 34: 61-8(1969). (In Polish).

The grafts sterilized by gamma rays were used in 160 cases (spine fusion for scoliosis and other specific and non-specific infections, in the treatment of recent and complicated fractures of the long bones, in arthrodesis, in the filling of bone defects and in various reconstructive procedures). In all 160 cases the operative wounds healed. Three recent and 2 late infections were due to other causes. The grafts were incorporated completely in 142 cases, partially in 7 cases; 6 failures were observed. On this basis the conclusion was reached that the dry-freezed gamma-irradiated grafts are not inferior to the grafts preserved by other methods and deserve a wide application in the clinical practice. (auth)

6157 CHANGES IN THE AMINO ACIDS COMPOSITION OF PROTEINS IN GAMMA-IRRADIATED MEAT. Fomin, A. A. (Altai Medical Inst., USSR). Gig. Sanit.; No. 9, 60-3(Sep 1969). (In Russian).

The amino acid composition of proteins in beef at different periods of time (3, 6, and 9 months) after its irradiation with doses of 0.6, 1.5, and 3 Mrad was studied. The most significant changes in the composition of amino acids occurred 9 months after irradiation: the amount of certain amino acids, mainly aromatic and heterocyclic, diminished while the content of aliphatic amino acids with a short carbon chain increased. Following long-term storage of irradiated meat the amount of certain essential amino acids (tryptophan, trionin, phenylalanin, etc.) decreased. (auth)

6158 RADIATION STERILIZATION OF PROTOTYPE MILITARY FOODS. III. PORK LOIN. Anellis, Abe; Berkowitz, D.; Jarboe, C.; El-Bisi, H. M. (Army Natick Labs., Mass.). Appl. Microbiol.; 18: 604-11(Oct 1969).

Ten lots of pork loin, packed in cans, were inoculated with approximately 10^6 Clostridium botulinum spores per can. Each lot was seeded with a different strain; five type A and five type B strains were used. The pack comprised 5,690 cans, including controls, and contained about 10^9 spores per dose. The cans were irradiated with ^{60}Co in the range of 0 to 5.0 MRad (0.5 MRad increments) at 5 to 25°C, incubated for 6 months at 30°C, and examined for swelling, toxicity, and recoverable C. botulinum. The minimal experimental sterilizing dose (ESD) based on non-swollen, nontoxic, but nonsterile end points was $2.5 < ESD \leq 3.0$ MRad, and based on nonspoiled sterile cans was $3.5 < ESD \leq 4.0$ MRad. The theoretical minimal radiation dose (MRD), the 12D equivalent, varied with the method of computation: 4.74, 4.33 ± 0.17, and 4.19 to 4.99 MRad were obtained by the Weibull, Spearman–Kärber, and Schmidt–Nank techniques, respectively. Calculation of D and MRD values by the conventional Schmidt–Nank method produced increasing values with rising dosage; this finding was compared with the data derived by the other two methods of calculation. Suggestions for estimating the MRD of a prototype radiation process are offered. (auth)

6159 STERILIZATION BY NUCLEAR RADIATION. Thalheimer, M. Mem. Acad. Chir., 93: 393-6(Apr. 12, 1967). (In French).

The following sources of radiation sterilization are described: Linear Accelerator of Electrons (Corbeville); French ^{60}Co Apparatus (Dagneux in l'Ain); Cesium-137 Apparatus (Saclay). Comparative costs of radiosterilization are discussed and some results obtained in various countries are reported. Doses of radiation required to sterilize tetanus spores and anthrax staphylococci are given. Sterilizing effects of radiation on the following materials are described: polyethylene, nylon, cotton, teflon, and medical supplies. (H.L.W.)

6160 STUDIES ON THE STORAGE OF FRUITS BY IRRADIATION. IV. ON THE STORAGE OF GRAPE AND PEACH. Kim, Hyong Soo.; Kim, Yeun Sik; Park, Kyong Tai (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul), 9: No. 1, 119-24(1969).

In order to keep the freshness of grapes and peaches as long as possible, ripe grapes and peaches were purchased from the local market, treated with CO_2 gas shock and ^{60}CO γ irradiation, then kept at 4 ± 1°C. The appearance, color change, pH, titratable acidity and reducing sugar were examined in the grape samples. Only appearance was examined in the treated peaches. It was possible to preserve peaches for 1 month with irradiation of 0.25 Mrad. There were no notable differences in appearance between the control and irradiated lot up to 1 month of storage, but after one and one-half months, discoloration and berry-fall-off phenomena began to occur beginning with the higher-dose irradiated lot. Prolonged preservation of grape by irradiation seems to be impracticable. (auth)

6161 STUDIES ON THE STORAGE OF FRUITS BY IRRADIATION. II. ON THE STORAGE OF STRAWBERRY. Kim, Hyong Soo; Kim, Yeun Sik; Park, Kyong Tai (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul), 9: No. 1, 111-18 (1969). (In Korean).

In order to prolong the shelf life by retaining their freshness and controlling putrefaction during the storage of strawberries, selected wholesome, fully ripened TAE-HAK 1, were treated with CO_2 gas shock for 3 hours and packaged in polyethylene film, irradiated 0.1 to 0.3 Mrad using ^{60}Co γ rays, and kept at 4 ± 2°C. The changes in appearance and chemical components were determined periodically. In CO_2 gas shock-treated lot, the effect of 3 days prolonged life was observed over controls. Total carotenoids were not affected much by irradiation and towards the end of storage, the irradiated lot retained more total carotenoids than the control lot. Right after irradiation, reducing ascorbic acid content decreased in accordance with the increase in irradiation dose. At the end of the storage 0.1 and 0.2 Mrad irradiated lots retained more than twice the reducing ascorbic acid of the control lot. 0.2 Mrad is hence proposed to be the optimum irradiation dosage in the cold storage of strawberries. It was possible to store them for 23 days. (auth)

6162 RADIATION PROCESSING AND THE ACTIVITY OF ENZYMES OF IMPORTANCE IN THE DETERIORATION OF FOODS OF ANIMAL ORIGIN. Rhodes, D. N. (Meat Research Inst., Bristol, Eng.). pp 49-62 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

Post-mortem enzymic reactions in foodstuffs derived from animal sources are of importance only in the muscle and organ meats of animals, birds and fish. The proteolytic activity is the main cause of deterioration in these foodstuffs during long-term storage and the rates of proteolysis are much higher in the organ meats kidney, liver or pancreas than in muscle. Radiation at doses high enough to sterilize microorganisms is not very effective in destroying enzymic activity, reducing proteolysis by about one half; at radurization levels the destruction is one quarter. Even at 40 Mrads some proteolytic activity in meats still persists. (auth)

6163 SUMMARIES, CONCLUSIONS, AND RECOMMENDATIONS OF THE PANEL. pp 103-8 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

Radiation preservation has been successfully applied to a number of food products and is under study for others. Microorganisms that cause spoilage or spread diseases can be effectively eliminated by ionizing radiation to give microbiologically stable foods. However, some foods contain tissue enzymes in such amounts that problems of changes in organoleptic properties (texture, color, flavor, odor) arise if no measures are taken to control their activity. This is due to the fact that enzymes in the cellular environment exhibit radiation resistance much higher than microorganisms do. Therefore, of paramount importance in the prevention of deterioration of food is the protection of the cellular integrity to prevent leakage of enzymes from subcellular particles after irradiation or to bring about the sensitization of the enzymes to increase the extent of their inactivation during irradiation. The need for exploring the enzymological aspects of food irradiation is therefore clearly indicated. Elucidation of these phenomena presents a challenge both to food science and to food irradiation technology and calls for more fundamental and applied research in these fields. Recognizing the importance of the above questions, the IAEA and FAO have convened a meeting, the first of its kind, to discuss problems and stimulate further work in two main areas: radiation effects on enzymes in the isolated state and in the cellular environment. After having discussed the papers presented by members of the Panel and a number of questions raised by the Secretariat, the Panel made recommendations for further research. (auth)

6164 ENZYMATIC STABILIZATION OF RADIATED MEATS. Cain, R. F.; Anglemier, A. F. (Oregon State Univ., Corvallis). pp 91-102 of Enzymological Aspects of Food Irradiation. Vienna, International Atomic Energy Agency, 1969.

From Panel on Enzymological Aspects of the Application of Ionizing Radiation to Food Preservation, Vienna, Austria. See STI/PUB-216; CONF-680465.

Stabilization of the enzymes of meat tissue is absolutely necessary in the protocol of γ radiation sterilization of this commodity.

While microbial sterility can be achieved at 4.0 Mrad, enzyme systems remain operative and active and will degrade the meat during storage. Changes in proteins due to radiation modify the reactions of the native enzymes. Experiments attempting to alter the pH of the meat before radiation have been less than successful. At present, the only practical approach to the problem of enzyme inactivation is one of heat treatment to the temperature range of 160–170°F. Flavor changes, as a result of enzyme activity, are effectively stabilized although the change in flavor induced by radiation alone persists. Radiation of meats at low temperatures has done much to reduce the initial flavor change while at the same time affording a sterile product. To provide fresh (raw) meats which, when radiated, are enzymatically stable, an entirely new approach is required. Hopefully, some day it may be possible to better understand the biological reactions of proteolytic enzymes and thus be in a position to block the reactions. Until that time, however, the only recourse is with some form of heat inactivation. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

6165 (BNWL-1142) A FINITE ELEMENT COMPUTER CODE (AXICRP) FOR CREEP ANALYSIS. Sutherland, W. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 59p. Dep. CFSTI.

Applications of the finite element computer code AXICRP developed for the purpose of solving creep problems for plane stress, plane strain, and axisymmetric bodies of revolution are described. The code represents an extension of an elastic finite element code to include the nonlinear effects arising from creep by the use of an incremental procedure. This procedure permits the utilization of any creep law expressible in the general functional form $\Delta\epsilon_e^c = F(\sigma_e, \epsilon_e^c, T, t)$. Principal application has been to obtain the creep solution for a Fast Flux Test Facility (FFTF) hexagonal flow duct. Other applications to a thick-walled cylinder and a rectangular beam demonstrate the variety of structural geometries which can be analyzed by the program. (auth)

6166 (ORNL-4270(Vol.1)(Rev.)) BIBLIOGRAPHY OF THE TECHNICAL LITERATURE OF THE METALS AND CERAMICS DIVISION FOR THE PERIOD 1948 THROUGH 1968. (Oak Ridge National Lab., Tenn.). Nov 1969. Contract W-7405-eng-26. 310p. Dep. CFSTI.

Nineteen hundred references are given to books, journals, reports, patents, and these published from 1948 through 1968. A master listing is included along with subject and author indexes, special and cross indexes, theses completed and published as ORNL reports, patents issued, and numerical listings of ORNL topical and technical reports and memorandums. (J.C.W.)

Corrosion and Erosion

Refer also to abstracts 5947 and 7116.

6167 (ORNL-tr-2249) ELECTROCHEMICAL STUDIES ON CORROSION OF CONDENSER TUBES BY POLLUTED WATER. PART I. Shimodaira, Saburo; Sugawara, Hideo; Sato, Takeaki. Translated for Oak Ridge National Lab., Tenn., from Sumitomo Keikinzoku Giho; 4: [No. 1], 31-47(1963). 37p. Dep. CFSTI.

Inspection of corrosion damage of aluminum-brass condenser tubes was made of the New Tokyo Steam Power Station using polluted estuarine water, thereafter the potentiostatic measurements of polarization curves of copper, copper alloys, and several other metals were carried out in slowly moving aqueous sodium-chloride solutions containing hydrogen sulfide. The following results were obtained: the principal corrodents were sulfur compounds, particularly hydrogen sulfide, and dissolved oxygen in polluted estuarine waters; sulfur compounds were released by the action of sulfate reducing bacteria; sulfur reducing bacteria may not be grown in the condenser tubes; the mechanism of corrosion reaction of copper alloys by polluted estuarine water was concluded to be that copper sulfide produced by reaction of copper with sulfur compounds acts strongly as cathodes of local corrosion cells. (Also, sulfur compounds can be a cathodic depolarizer, therefore, the corrosion of copper alloys is unusually violent. It is a characteristic of the corrosion that both dissolved oxygen and sulfur compounds act as cathodic depolarizer. The corrosion is cathodically controlled in local corrosion cells); and chromium, tin, nickel and silver may be effective alloying elements in copper alloys against the corrosion by polluted estuarine water. Aluminum may be effective in the range of natural electrode potential less noble than −0.50 V, but injurious in the more noble range. (auth)

6168 QUASI-EQUILIBRIUM TREATMENT OF GAS-SOLID REACTIONS. II. FLASH DESORPTION OF OXIDATION PRODUCTS FROM A TUNGSTEN SURFACE. Batty, J. C.; Stickney R. E. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 51: 4485-92(15 Nov 1969).

The quasiequilibrium treatment of heterogeneous reactions is applied to the flash desorption data of Ptushinskii and Chuikov [Surface Sci. 6: 42 (1967)] for the reaction of oxygen with a tungsten surface. Comparison of the theoretical and experimental results provides support for the view that, in the present case, flash desorption may be considered to be a quasistatic process (i.e., the adsorbate passes through a continuous series of equilibrium states). On this basis, the quasiequilibrium treatment is used to develop a semiquantitative explanation of the experimental observation that the amounts of the various oxide species desorbed per flash depend upon the adsorption temperature. (auth)

6169 QUASI-EQUILIBRIUM TREATMENT OF GAS-SOLID REACTIONS. I. EVAPORATION RATES OF VOLATILE SPECIES FORMED IN THE REACTION OF O_2 WITH W, Mo, AND C. Batty, J. C.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 51: 4475-84(15 Nov 1969).

A quasiequilibrium treatment of heterogeneous reactions is used to compute the rates of evaporation (desorption) of volatile species formed in the reaction of gaseous O_2 with solid tungsten, molybdenum, and graphite under conditions of low pressure and high temperature. The results are compared with existing mass-spectrometric data for the O−W and O−Mo reactions, and the agreement is surprisingly close at the highest temperatures in view of the extreme simplicity of the theoretical model. Significantly better agreement is obtained over the entire temperature range (1400−3100°K) when an empirical method is introduced to account for the fact that not all of the molecules impinging upon the solid surface attain complete thermodynamic equilibrium with both the solid and adsorbate phase. It appears that the present treatment correctly predicts both the temperature dependence and the pressure dependence of the evaporation rate of each volatile species, as well as predicting that the proportions of the species will be those of an equilibrium mixture. The principal advantages of the quasiequilibrium treatment over existing kinetic treatments of gas−solid reactions are (1) the only empirical parameter is the equilibration or sticking probability, and (2) results are obtained without assuming microscopic models of the adsorbate phase and the reaction mechanism. (auth)

6170 STUDY OF THE INFLUENCE OF VARIOUS THERMO-MECHANICAL TREATMENTS ON THE PROPERTIES OF CORROSION-RESISTANT ZIRCONIUM ALLOYS IN ORGANIC ENVIRONMENT. Barigozzi, F. (SNAM-Progetti, San Donato Milanese, Milan); Boerman, D.; Bonnet, P. Mem. Sci. Rev. Met.; 66: 649-64(Sep 1969). (In French).

Four types of alloy with given compositions were studied. The effects of cold rolling (30, 50 or 60%), and annealing at 350 to 750°C for times varying from 20 minutes to 200 hours were investigated. The hardness, texture, and microstructure were determined. (auth)

6171 EFFECT OF OXYGEN PRESSURE ON THE OXIDATION PROCESS OF TUNGSTEN. Rybalko, V. F.; Kolot, V. Ya.; Fogel, Ya. M. (Physical Technical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 11: 1142-3(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1404-6(May 1969).

A study was made of the changes in the oxide layer on the W surface during a change in the O_2 pressure (varied from 0 to 15×10^{-6} torr). The secondary ionic-ionic emission method was used. The shape of the I(p) curve (I = secondary ion beam current) is that of the Langmuir isotherm, reaching saturation at the higher pressures, and the changes are reversible. Besides WO_2, an increase in the O_2 pressure leads to the appearance of the oxides W_2O, WO, and W_2O_6. Their n(T) curves (n = surface concentration) are reversible, and above 1700°K, evaporation of these oxides commences. (D.L.C.)

6172 EFFECT OF FLOWING SODIUM ON 304 SS FUEL CLADDING. Millhollen, M. K.; Myers, R. L.; Bennett, T. J.; Thornton, J. W. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 610-11(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6173 CARBON TRANSPORT UNDER A TEMPERATURE GRADIENT IN FLOWING SODIUM. Roy, Prodyot; Wozadlo, Gary P. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 612(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6174 STUDIES OF CESIUM DEPOSITION IN A SODIUM/STAINLESS-STEEL SYSTEM. Guon, J. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 612-13 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6175 SOLUBILITY EXPERIMENTS WITH Bi, Mo, Ti, AND Cr IN LIQUID SODIUM. Eichelberger, R. L.; Gehri, D. C.; Sullivan, R. J. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 614(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6176 INTERSTITIAL TRANSFER IN A VANADIUM ALLOY/STAINLESS-STEEL BIMETALLIC LIQUID-METAL SYSTEM. Whitlow, G. A.; Schrock, S. L. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 615-16(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6177 OPTIMIZATION OF THE COMPOSITION OF 20 PERCENT Cr/25 PERCENT Ni/Nb STEELS FOR A CIVIL AGR SYSTEM ON THE BASIS OF OXIDATION RESISTANCE. Francis, J. M. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc.: 8: 333-9(Oct 1969).

High-temperature oxidation studies of a series of 20% Cr/25% Ni/Nb stabilized steels modified with respect to minor alloying elements are described. These were compared with the oxidation behavior of the standard steel employed for fuel cladding in the Windscale AGR. The investigation covers the temperature range 750 to 950°C in pure CO_2, and a timescale of up to 1000 hr/total exposure. Thermogravimetric and x-ray analytical methods were used to study oxide composition and structure during oxidation. (auth) (UK)

Preparation and Fabrication

6178 (BAW-3714-11) FABRICATION OF PLUTONIA-URANIA PELLET, SHARD, AND SPHERE IRRADIATION SPECIMENS. Ferrell, L. J. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Sep 1969. Contract AT(30-1)-3714. 132p. Dep. CFSTI.

An irradiations testing subtask was established to evaluate the effects of heat rate and time on the restructuring characteristics of sol-gel UO_2-PuO_2 spheres and angular particles prepared from coprecipitated UO_2-PuO_2. The techniques and procedures described were used to fabricate the fuel pins for tests. Thirty-one fuel pins were fabricated and divided into groups of 12 angular-particle pins, 7 sphere pins, and 12 pellet pins. The pellet pins were for a reference pin in each capsule. The fuel used in these pins consisted of UO_2-20 wt % PuO_2. In approximately half of the pins the UO_2 was enriched to 20 wt % ^{235}U. The fuel smear density on all as-fabricated pins was in the range of 82 ± 2% theoretical density. (auth)

6179 (TEE-3874-1) TOPICAL REPORT: STUDY OF VAPOR-DEPOSITED TUNGSTEN AND TUNGSTEN-RHENIUM ALLOYS FOR USE AS THERMIONIC EMITTERS. van Someren, L. (Thermo Electron Corp., Waltham, Mass.). 30 Jun 1969. Contract AT(30-1)-3874. 58p. (TE-4086-166-69). Dep. CFSTI.

The spatial distribution of a single crystal-plane in a polycrystalline specimen can be explored by x-rays, and the resulting pole figure can be useful either in ranking members of a set of specimens according to their degree of preferred orientation, or in studying the dependence of the microstructure on mechanical and thermal treatment of the specimen. Vapor deposited and wrought W specimens have been examined. It is found that grinding produces a randomly oriented surface; mild heat treatments typically used in emitter preparation recrystallize this very little, so that the highly oriented emitters often used may in fact have a nearly randomly oriented surface. The heat treatment necessary to recrystallize the random layer and regenerate the underlying orientation is indicated. It is found that the removal of two mils of tungsten by electropolishing is sufficient to eliminate the random layer introduced by grinding and to expose the substrate orientation. Five tungsten-rhenium alloys containing not more than 26% Re were prepared by vapor deposition onto tungsten substrates. Samples were subjected to various heat treatments and surface preparations and examined metallographically and by x-ray diffraction. Bare work function measurements failed to reveal any clear trend in the work function that could be attributed unambiguously to the effect of rhenium additions. (auth)

6180 EFFECT OF DISPERSED OXIDE PARTICLES UPON SINTERING OF METALLIC COMPACTS. Kuczynski, George C. (Univ. of Notre Dame, Ind.); Lavendel, Henry W. Int. J. Powder Met.; 5: No. 4, 19-26(Oct 1969).

The effects of fine dispersed oxide particles on the neck formation between particles during sintering, as well as on the linear shrinkage of the composite compacts are described. The critical radius of a spherical pore as a function of the volume fraction of the dispersoid are described. (auth)

6181 MOLECULAR DEPOSITION OF THE TRANSPLUTONIUM ELEMENTS FROM AN ORGANIC EXTRACTANT. Kappelmann, F. A.; Baybarz, R. D. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 515(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6182 IMPROVED PROCESSES FOR THE FABRICATION OF 316 STAINLESS-STEEL TUBING. Reimann, G. A.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 569-70(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6183 METHOD AND APPARATUS FOR THE PRODUCTION OF FUEL AND/OR BREEDER ELEMENTS FOR NUCLEAR REACTORS. (to Kernforschungsanlage GmbH). British Patent 1,170,740. 12 Nov 1969. Priority date 16 Dec 1965, Germany.

A spherical core body was formed from a suitable material. It is permissible to use the same material for the core body and the casing, but it has been found expedient in some cases to make the casing and the core body from the same material. Hard carbon, graphite, ceramic material, or sintered metal are used as materials for the bodies for receiving the fuel and/or breeder materials. The core body has cast around it a filler which consists of a metal which melts at a low temperature. Two pins are secured to the body core being arranged in equi-spaced relation to one another and serving to centralize the core body within a mold for the application of the casing, which is cast around the filler. The filler is then melted out leaving only the core body and the casing. This element is then heat treated to effect the graphitizing operation. The fuel and/or breeder materials are introduced into the space between the core body and casing, and the casing is sealed. The apparatus for performing the fabrication is described. (J.C.W.)

Properties Evaluations

Refer also to abstracts 5655, 5773, 5774, 5830, 6179, 6230, 6240, 6272, 6641, 6645, 6658, 7105, 7106, and 7353.

6184 (NP-18033) P.F.R. M316 STAINLESS STEEL CLADDING PRODUCT SPECIFICATION FOR U.S./U.K. EXCHANGE. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Aug 1969. 20p. Dep. CFSTI (U. S. Sales Only).

Product specifications for stainless steel fuel cladding, tubes, and reactor core honeycomb grids are presented. Specifications for mixed plutonium oxide-uranium oxide fuels are also included. (J.R.D.)

6185 (RLO-1375-18) A STUDY OF PHASE TRANSFORMATIONS AND SUPERCONDUCTIVITY. Progress Report No. 10. Polonis, Douglas H. (Washington Univ., Seattle. Coll. of Engineering). 15 Oct 1969. Contract AT(45-1)-1375. 26p. Dep. CFSTI.

Electron microscopy studies of the martensite transformation in titanium alloys are described. Significant progress has been accomplished in each phase of the program and several problem areas for future studies have been defined. In Phase I of the program the structure of the martensitic phases that occur in Ti-Cu alloys containing up to 8 wt % copper has been investigated using transmission electron microscopy. It has been determined that a massive martensite phase forms in alloys containing less than 4% copper; whereas, an acicular martensite occurs in the higher alloys. The mode of lattice invariant deformation in the massive martensite has been identified as $\frac{1}{2}[2\bar{1}\bar{1}3]$, and this result has been successfully correlated with recent calculations. On the basis of observations made during the electron microscopy studies, a model has been developed to account for the transition from the massive to the acicular martensite morphology. Electron microscopy techniques have been employed to study the decomposition of the martensitic and supersaturated alpha phases. The precipitation process has been observed to occur in two stages; the heterogeneous nucleation of Ti_2Cu at the martensite substructure and the homogeneous nucleation of coherent Cu-rich zones that develop into the equilibrium Ti_2Cu phase in a four-stage sequence. The results obtained have pointed clearly to the usefulness of superconducting transition temperature measurements in conjunction with electron microscopy techniques for the study of phase transformation phenomena in titanium and zirconium base alloys. Significant progress has been accomplished in an investigation to resolve the mechanism that controls the decomposition of the beta phase in these alloys. A study of omega phase formation and its relationship to the initial stages of the decomposition of the parent beta phase has led to the conclusion that composition fluctuations develop in the beta phase during quenching as a result of diffusional processes. In an alloy that is all-beta in the quenched condition, such fluctuations are intensified during aging as the omega phase nucleates. The various stages of the nucleation and growth processes have been monitored by examining the details of the specimen inductance change during the transition from the normal to the superconducting state. For the systems that have been studied

in this program it has been observed that the average superconducting transition temperature is depressed as the omega phase forms. (auth)

6186 (UCRL-50637) A SLOW-IRRADIATION METHOD FOR DETERMINING SPECIFIC HEATS OF METALS. Hassett, Scott E. (California Univ., Livermore. Lawrence Radiation Lab.). 9 Apr 1969. 22p. Dep. CFSTI.

Two metal disks of identical size, one of which is made of a material of known specific heat and the other of a material whose specific heat is to be determined, are irradiated equally under infrared lamps. The disks are painted black to ensure equal absorption. These disks absorb energy at a slow rate compared to the time it takes for thermal equilibrium to occur. A thermocouple is attached to the back of each disk to record a continuous heating and cooling curve. The cooling curve is used to calculate the rate of heat loss for each disk as a function of temperature. The heating curve for the disk of known specific heat is used to calculate the heat input. From a single test a continuous curve of specific heat versus temperature can be obtained. (auth)

6187 THE RELATION BETWEEN THE DUCTILE-BRITTLE TRANSITION TEMPERATURE AND GRAIN SIZE IN POLYCRYSTALLINE MOLYBDENUM. Thornley, J. C.; Wronski, A. S. (Univ. of Bradford, Eng.). Scr. Met.; 3: 935-8(Dec 1969).

The mechanism of the ductile-brittle transition in polycrystalline Mo is reported for the variations of transition temperature with grain size. Specimens were prepared from two arc-cast rods and one Murex sintered rod, each 5 mm in diameter. Data on mechanical and thermal treatments and the resultant grain sizes are tabulated. Some specimens exhibited appreciable microstrain and no upper yield points. Only ductile specimens exhibited microcracks. Transition temperatures can be unaffected, lowered, or raised by coarsening the grain size. Further studies showed that the transition temperature in cast material is directly influenced by the annealing temperature which in the region of 1200 to 1600°C affects the size and distribution of precipitates. (J.C.W.)

6188 ELECTROMIGRATION AND THERMOMIGRATION IN GAMMA-URANIUM. D'Amico, J. F.; Huntington, H. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Phys. Chem. Solids; 30: 2607-21(Nov 1969).

Atom transport produced by large direct currents (electromigration) and thermal gradients (thermomigration) was measured in gamma-uranium by observation of local dilatations induced in high purity rods which were heated with a.c. or d.c. in a vacuum of 10^{-8} Torr. or better. Both radial and longitudinal dimensional changes (the latter obtained from displacements of surface markers) were measured in order to determine the atom flux. Rates of dimensional change were observed to be constant during the 8-12 days duration of the experiments. In the d.c. experiments, where the electromigration effect dominated, mass transport was observed toward the anode with Z^*/f equal to -1.6 ± 0.1 where f is the tracer diffusion correlation factor. The small negative value for Z^*, the effective charge, indicates a dominance of the electron "wind" force over the combined forces of the hole "wind" and the electrostatic field. In the a.c. experiments mass transport was observed toward the cooler regions with Q^*/f equal to $+4.7 \pm 0.5$ kcal/mole. If the Wirtz model is adopted for a vacancy mechanism, the thermomigration results imply a relatively large migration enthalpy and a correspondingly small formation enthalpy; the latter leads to a vacancy fraction at melting of about 2.7 per cent. Semi-log plots of DZ^*/f and DQ^*/f vs. $1/T$ were found to be linear, with "activation energies" of 27.2 ± 0.6 and 23.0 ± 1.6 kcal/mole, respectively. The former agrees with the activation energy obtained from tracer experiments, while the latter is slightly less. A possible explanation is that Q^* has some temperature dependence, which is not surprising in view of the large absolute thermoelectric power of gamma-uranium. (auth) (UK)

6189 SOME PECULIARITIES IN ELECTRICAL CONDUCTIVITY OF LIGHT RARE-EARTH METALS LANTHANUM, CERIUM, PRASEODYMIUM, AND NEODYMIUM IN THE SOLID AND THE LIQUID STATES. Gaibullaev, F.; Regel, A. R.; Khusanov, Kh. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 11: 1138-9(Nov 1969).
Translated from Fiz. Tverd. Tela; 11: 1400-2(May 1969).

Electric conductivity measurements were made on La, Ce, Pr, and Nd at 20 to 1200°C. The results for the solid state are in good agreement with literature. Small jumps, up to 5%, occur owing to phase transformations and fusion. It is concluded that no significant changes in the band structure and conduction mechanism occur during fusion. (D.L.C.)

6190 MICROHARDNESS OF GADOLINIUM NEAR THE CURIE POINT. Nabutovskaya, O. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 11: 1172-3(Nov 1969).
Translated from Fiz. Tverd. Tela; 11: 1434-6(May 1969).

The microhardness of Gd was measured at 230 to 330°K. It was found to decrease slowly as the phase transition temperature (293°K) is approached, except in the 273.7 – 284.8°K range, where it increases abruptly. The smallest value is observed at 292°K. A linear relation is found between the microhardness and the heat capacity. (D.L.C.)

6191 LOW-TEMPERATURE INTERNAL FRICTION IN DEFORMED SINGLE CRYSTALS OF NIOBIUM AND NIOBIUM-MOLYBDENUM ALLOYS. Amateau, M. F.; Mitchell, T. E.; Gibala, R. (Case Western Reserve Univ., Cleveland). Phys. Status Solidi; 36: 407-18(1 Nov 1969).

The low-temperature internal friction spectrum has been measured on single crystals of Nb and Nb-Mo alloys deformed in tension. The α-peak height is found to increase in proportion to the square of the work-hardening stress and, therefore, in direct proportion to the dislocation density. The addition of interstitial impurities or substitutional molybdenum is found to increase the frequency factor of the α peak without changing the activation energy. The maximum peak height is decreased substantially both by impurities and by decreasing the deformation temperature. It is concluded that the α peak is similar to the Bordoni peak in fcc metals and is due to either an intrinsic dislocation mechanism (most likely kink nucleation on nonscrew dislocations), which is sensitive to impurities, or an extrinsic mechanism in which impurities are more directly involved. Some preliminary observations on the β-peak are also presented. (auth)

6192 EFFECT OF THERMAL TREATMENT ON THE HALL MOBILITY IN THIN VANADIUM FILMS. Jain, S. C.; Chander, Ramesh (Solid State Physics Lab., Delhi. National Physical Lab., New Delhi). Thin Solid Films; 4: R11-13(Aug 1969).

A study was made of the effects of vacuum heat treatment on the Hall mobility of charge carriers in vacuum-evaporated V films of thickness 100 to 700 Å. The heat treatment consisted of heating to 200°C at a rate of 3°C/min and cooling at the same rate. The plot of Hall mobility change vs thickness shows that the percentage change is positive for films thicker than 225 Å and negative for thinner films. The results indicate that, in addition to oxidation, annealing of defects occurs. (D.L.C.)

6193 STELLITE HARD SURFACE TREATMENT OF AUSTENITIC STAINLESS STEELS FOR NUCLEAR REACTOR COMPONENTS. Cappelli, Giorgio; Frigerio, Giovanni (FIAT, Turin). Riv. Ital. Saldatura, 20: No. 2, 51-9(1968). (In Italian).

Some stellite No. 6 hardsurfacing tests are described with coatings applied by oxyacetylene, TIG, and coated electrode welding methods on AISI 304 and 316 stainless steel components for service in nuclear reactor pressurized water. Factors other than coating hardness for the method chosen to coat a component are discussed. An example is described of using the TIG welding method rather than oxyacetylene for an inaccessible surface. (J.C.W.)

6194 INTERNAL FRICTION DUE TO LONG-RANGE DIFFUSION OF HYDROGEN IN NIOBIUM (GORSKY EFFECT). Cantelli, R.; Mazzolai, F. M.; Nuovo, M. (Consiglio Nazionale delle Ricerche, Rome). Phys. Status Solidi, 34: 597-600(Aug. 1, 1969).

The Gorsky effect is investigated by internal friction measurements in the niobium-hydrogen system at a vibration frequency of 16 Hz. The diffusion coefficient D of hydrogen in niobium is measured as a function of temperature. It is found that D, in the temperature range from ≈235 to ≈830°K, obeys the Arrhenius relation $D = D_0 \exp[-W/kT]$ with $D_0 = 5.4 \times 10^{-4}$ cm²/sec and $W = (0.109 \pm 0.005)$ eV. A deviation from the exponential law is observed at lower temperatures. (auth)

6195 ISOCHROMAT STRUCTURES OF TUNGSTEN FOR QUANTUM ENERGIES FROM 0.15 TO 6 keV. Boehm, G.; Ulmer, K. (Univ., Karlsruhe, Ger.). Z. Phys., 228: 473-88(1969). (In German).

A systematic investigation is presented on the variation of isochromat structures with threshold voltage (quantum energies). With a double-focusing x-ray monochromator, highly resolved bremsstrahlung isochromats of tungsten are measured in the quantum energy range from 0.15 to 6 keV. Crystals with lattice constants up to about 50 Å could be used as dispersing devices. The initial parts of the isochromats (primary structure) turned out to be essentially independent of quantum energy. With the high resolution of the monochromator at quantum energies below 0.9 keV, a fine structure in the primary structure of the corresponding isochromats could be observed. This fine structure is

in qualitative agreement with a theoretical density of states calculated by Mattheiss. The following parts of the isochromats (secondary structure) depend strongly on quantum energy. These structures can be understood by the influence of characteristic energy losses in the target of the primary electrons. (auth)

6196 ELECTRICAL RESISTIVITY OF TUNGSTEN FILMS PREPARED BY WF_6 REDUCTION. Madyadas, A. F.; Cuomo, J. J.; Rosenberg, R. (International Business Machines Corp., Yorktown Heights, N. Y.). J. Electrochem. Soc.; 116: 1742-5 (Dec 1969).

Electric conductivity measurements were made on polycrystalline and epitaxial single-crystal tungsten films prepared by hydrogen reduction of WF_6. Polycrystalline films exhibited room temperature resistivities about 30 to 100% higher than the published bulk value of 5.3 μohm × 3m, and low conductivity ratios: about 2 to 4. Measurements on the single-crystal films were generally within a few per cent of the bulk conductivity and were essentially independent of thickness in the range 1500 to 10,000 Å. Measured values of $\rho_{4.2°K}$ (and hence resistivity ratio), however, were strongly dependent on thickness. It was concluded that the high conductivity in the polycrystalline W films was not due to impurities but to grain boundary scattering of electrons, since polycrystalline and single-crystal films deposited simultaneously have quite different resistive characteristics. (P.C.H.)

6197 EFFECT OF DEFECTS ON THE RUPTURE DUCTILITY OF TYPE-304 STAINLESS-STEEL TUBES UNDER BIAXIAL LOAD. Yaggee, F. L.; Wang, I-chih (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 570(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6198 CORRELATION OF THE CREEP BEHAVIOR OF A NICKEL ALLOY WITH PRECIPITATE DISTRIBUTION. Sessions, C. E.; Gehlbach, R. E.; Cook, S. W.; McCoy, H. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 570-1(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6199 VOID VOLUME DETERMINATION OF IRRADIATED FUEL RODS. Barnes, J. T.; Turel, S. P. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 847 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6200 EXPERIMENTAL DETERMINATION OF THE BOILING POINT OF URANIUM. Randol III, A. G.; Schneider, R. T.; Kylstra, C. D. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 12: 541-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6201 THEORETICAL ANALYSIS OF CLADDING STRESSES AND STRAINS PRODUCED BY EXPANSION OF CRACKED FUEL PELLETS. Gittus, J. H.; Howl, D. A.; Hughes, H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Trans. Amer. Nucl. Soc., 12: 525(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6202 HALL EFFECT IN TERBIUM–YTTRIUM AND DYSPROSIUM–YTTRIUM ALLOYS IN A PARAMAGNETIC FIELD. Volkov, D. i.; Kozlova, T. M.; Shafigullina, G. A. (Moscow State Univ.). Fiz. Metal. Metalloved.; 27: 67-71(Jan 1969). (In Russian).

Results are reported from an investigation of paramagnetic susceptibility and the Hall effect in the rare earth alloys Tb–Y and Dy–Y containing 100, 90, 69, 56.7, 35.9, and 27.1 at.% Tb with the remainder Y, and 100, 83, 55.8, 44.8, and 26.6 at.% Dy with the remainder Y in the paramagnetic field of temperatures. The constants of classical R_B and anomalous R_P of the Hall effect were determined and the magnetic moments and effective numbers of the current carriers per atom of alloy were calculated. (tr-auth)

6203 CURRENT FLOW IN A SINGLE ZONE SUPERCONDUCTOR WITH PARAMAGNETIC IMPURITIES. Kolpazhiu, M. K.; Moskalenko, V. A. (Inst. of Mathematics and Computer Center, Kishinev). Fiz. Metal. Metalloved.; 27: 42-52(Jan 1969). (In Russian).

The influence of paramagnetic impurities on the current flow in a single zone isotropic superconductor was studied and showed that the maximum value of the current near the critical temperature decreases with an increase in concentration of paramagnetic impurities according to the law $(1 - T/T_c)^{\frac{1}{2}}$. The critical value of the impurity concentration at which superconductivity disappears was found at T equals zero. (tr-auth)

6204 SELF AND SOLUTE DIFFUSION IN ZIRCONIUM. II. THE EFFECT OF COBALT ADDITIONS ON THE DIFFUSION OF ^{95}Zr AND ^{60}Co IN β-ZIRCONIUM. Kidson, G. V. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Kirkaldy, J. S. Phil. Mag.; 20: 1057-74(Nov. 1969).

The effects of cobalt additions on the diffusion rates of ^{95}Zr and ^{60}Co in bcc zirconium were measured for cobalt concentrations between 0.0 and 2.0 at.% at an annealing temperature of 933°C. The diffusion coefficient of ^{95}Zr is markedly increased between 0.4 and 2.0 at.% cobalt while that of ^{60}Co is slightly decreased. An analysis of the results in terms of the deduced correlation factor for the cobalt solute indicates that diffusion does not occur by a single vacancy mechanism alone. The results are compatible with a model in which both single vacancies and dislocations contribute to the diffusion process. The vacancy component for the zirconium self-diffusion, however, is very much larger than predicted from empirical relations. The dislocation component can be accounted for in terms of a dislocation density between 2×10^5 and 2×10^8 lines/cm^2. (auth) (UK)

6205 MAGNETIC HYSTERESIS OF SUPERCONDUCTING ALLOYS. Potapov, N. N.; Zaikina, G. I. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Fiz. Metal. Metalloved.; 27: 53-8(Jan 1969). (In Russian).

The magnetic hysteresis of sintered superconducting alloys containing Nb and Sn with 7.2 to 83.5 at.% Nb was studied after cooling the specimens from room temperature to the temperature of liquid helium in a longitudinal magnetic field. The data obtained were correlated with the phase composition of the alloys. The causes of hysteresis property changes in the alloys depend on the composition of the specimen and the rate of cooling after sintering. (tr-auth)

6206 SURFACE PROPERTIES OF GERMANIUM IRRADIATED BY IONS OF AVERAGE ENERGY. Pavlov, P. V.; Popov, H. S. (Gorky Scientific-Research Physical-Technical Inst., USSR. Gorky State Univ., USSR). Fiz. Tekh. Poluprov.; 3: 546-9(Apr 1969). (In Russian).

Specimens of n-type Ge were bombarded by ions of argon, helium, and nitrogen at 50 kV energy in the dose range of 0.1 to 1000 μCl/cm^2. Surface conditions after irradiation were studied by the field effect methods on sinusoidal tension together with stationary photoconductivity. The contact potential difference and temperature as a function of lifetime were measured. An increase in density of fast capture centers was discovered. The yield point was observed to increase with increasing radiation doses and was limited by the deformation of the surfaces. (tr-auth)

6207 INTERACTION OF LIQUID SILICON WITH REFRACTORY METALS. Kostikov, V. I.; Levina, N. P.; Levin, V. Ya. (Moscow Inst. of Steel and Alloys). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 152-4(Jan 1969). (In Russian).

Studies were made of the interaction of liquid silicon with tungsten, molybdenum, and niobium. The kinetics and distribution of silicon on the surfaces of tungsten, molybdenum, and niobium were measured according to the thickness of the silicide layers which were formed as a result of the diffusion of silicon in the respective metals. The distribution of liquid silicon on the metal surfaces was conducted in a vacuum furnace at 1 to 5×10^{-4} mm Hg at 1430°C. The highest mean rate of distribution of melted silicon was found on niobium. The studies of the spreading and diffusion showed that the highest reaction occurred in Mo–Si and the lowest in Nb–Si. (tr-auth)

Structure and Phase Studies

Refer also to abstracts 6185, 6188, and 6220.

6208 INVESTIGATION OF TUNGSTEN–SILICON SYSTEMS. Maksimov, V. A.; Shamrai, F. I. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 1136-7(Jun 1969). (In Russian).

Thermal analysis established that compounds of W_5Si_3 melt congruently at approximately 2320°C. The temperature of eutectic formation was approximately 2180°C. Thermal analysis of the alloys W_5Si_3, WSi_2, and WSi_2–Si showed that eutectic W_5Si_3 plus WSi_2 was formed at 2010°C and eutectic WSi_2 plus Si at 1390°C. The results of thermal and microstructural analyses were used to construct the phase diagram for W-Si. X-ray analysis of powders of these alloys containing 25.6 and 33.5% Si showed that these alloys contain only solid solution of Si in W and W_5Si_3. (tr-auth)

6209 INTERNAL FRICTION PEAK DUE TO OXYGEN IN A Nb–Mo ALLOY. Vercaemer, Claude; Clauss, Auguste (Univ.,

Strasbourg). Compt. Rend., Ser. C; 269: 803-6(13 Oct 1969). (In French).

In the Nb–5.3 % Mo alloy the Snoek peak due to oxygen is displaced toward higher temperatures with respect to the peak in nonalloyed niobium. The variation in the height of the peak as a function of the concentration of oxygen was studied, and it was concluded that it is possible to determine interstitial oxygen by this method. (tr-auth)

6210 TEXTURE CONTROL IN ZIRCALOY TUBING. Hobson, David O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 571-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6211 BEHAVIOR OF POINT DEFECTS IN METALS. Balluffi, R. W. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 12: 699(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6212 STRUCTURE AND PROPERTIES OF THIN VACUUM CONDENSATES OF MOLYBDENUM. Belomytsev, Yu. S.; Yaroshevich, P. Yu.; Saratovskii, L. N.; Pavlovich, T. M. Fiz. Metal. Metalloved.; 27: 77-80(Jan 1969). (In Russian).

The structure and properties of thin vacuum condensates of Mo were studied as a function of temperature and rate of condensation. It was shown that at low temperatures a fibrous structure occurs and at high temperatures column-like crystals appear. The dimensions of the column-like crystals increased with an increase in rate of condensation. (tr-auth)

6213 DEFORMATION OF REFRACTORY METALS AND ALLOYS IN VACUUM AT HIGH TEMPERATURES. Zakharov, A. M.; Druzhinin, I. I. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 135-8(1969). (In Russian).

An investigation was conducted of the deformability of binary alloys of Mo and Nb with impurities of C, Hf, Ti, and Zr and of ternary alloys of Mo with C and Hf. Phase diagrams of the cross-section of Mo–Hf–C alloys were obtained. The apparatus used for studying the deformation of refractory metals and alloys in vacuum at high temperatures is described. From the deformation data obtained it was concluded that at 2100°C, the annealing time required for the cast Mo–Hf–C alloy to reach an equilibrium state can be reduced by a factor of 2.5; and at 1250°C, the annealing time can be reduced by a factor of 1.5. (tr-auth)

6214 X-RAY STUDY OF THE TUNGSTEN–IRON–BORON AND TUNGSTEN–COBALT–BORON SYSTEMS. Kuzma, I. B.; Chepiga, M. V. (Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 49-53(Jan 1969). (In Russian).

In the system W–Fe–B, the compound $W_3Fe_3B_2$ (30 to 35 W, 30 to 25 Fe, 40 at. % B), was discovered with the U_3Si_2-type (a = 5.753 to 5.739; c = 3.161 to 3.159 Å, with partially regulated distribution of atoms). This compound exits at temperatures above 1300°C. It was established that WCoB, possesses the rhombic structure of TiNiSi-type (steric group $Pnma-D_{2h}^{16}$; a = 5.745 ± 0.003; b = 3.203 ± 0.002; c = 6.652 ± 0.004 Å). (tr-auth)

Radiation Effects

Refer also to abstracts 6225 and 7371.

6215 (AECL-3291) REPLICA ELECTRON MICROSCOPIC OBSERVATION OF FISSION GAS BUBBLES IN UC PINS AFTER POST-IRRADIATION ANNEALING. Oi, N. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). July 1969. 39p. Dep. CFSTI (U. S. Sales Only).

Uranium carbide pins of hyperstoichiometric (C = 5.1 wt %) and hypostoichiometric (C = 4.65 wt %) compositions, which had been irradiated to 20,000 MWd/teu at ~300°C, were annealed at various temperatures ranging from 1000 to 1800°C. The annealed pins were fractured and the fracture surfaces were examined by replica electron microscopy. Fission gas bubbles became noticeable in hypostoichiometric UC after annealing at 1000°C and in hyperstoichiometric UC after annealing at 1200°C. In hypostoichiometric UC, fission gas bubbles nucleated homogeneously; in hyperstoichiometric UC, they nucleated heterogeneously with stringers of larger bubbles at the UC_2 platelets (Widmanstätten structure) and numerous small bubbles within the grains. The volume fraction of fission gas bubbles, the bubble density, and the gas content in the bubbles were calculated from the electron micrographs. At lower temperatures (<1500°C) the volume increase due to fission gas bubble growth in hyperstoichiometric UC was found to be much smaller than that in hypostoichiometric UC, but at higher temperatures it was greater. The relative behavior of hyperstoichiometric and hypostoichiometric UC in these experiments was consistent with the reported irradiation performance below 1500°C. (auth)

6216 VACANCY AND INTERSTITIAL LOOPS IN GRAPHITE SINGLE CRYSTALS REACTOR-IRRADIATED AT 900° AND 1200°C. Heerschap, M.; Schuller, E. (EURATOM, Petten, Netherlands). Carbon, 7: 624-5(Oct. 1969).

Graphite single crystals were irradiated to 10^{21} n/cm^2 at 900 and 1000°C. Electron micrographs showed that at 900°C interstitial loops were hexagonal with small vacancy clusters at the center, whereas at 1000°C they were circular with small well-resolved vacancy loops at the periphery. An indication is given of how the nature of the loops is determined. (UK)

6217 FORMATION OF VOIDS IN IRON DURING HIGH TEMPERATURE NEUTRON IRRADIATION. Kulcinski, G. L.; Mastel, B.; Brimhall, J. L. (Battelle Memorial Inst., Richland, Wash.). Radiat. Eff.; 2: 57-9(Nov 1969).

Results of an experiment showing radioinduced voids in high purity iron are discussed. Iron foil specimens of 99.999% purity were irradiated in EBR-II. The shape of the voids is non-uniform and the average diameter is 280 Å. The smallest voids found were ~100 Å in diameter and the distribution of the voids was calculated as 1×10^{14}/cc. Data on other pure metals are included for comparison. (J.R.D.)

6218 THE EFFECTS ON THE MECHANICAL PROPERTIES OF COPPER FROM DEFECTS PRODUCED BY IRRADIATION AT LOW TEMPERATURES. Nielsen, Robert LeRoy. Pittsburgh; Univ. of Pittsburgh (1968). 134p.

Thesis.

Polycrystalline wires and etched single-crystal samples of copper were irradiated near 4.2°K by 8.9-MeV protons. Measurements of internal friction and the dynamic Young's modulus were made by electrostatically driving the cantilevered sample in its lowest flexural resonant modes. All samples subjected to integrated fluxes exceeding 2×10^{16} p/cm^2 exhibited a decrease in the dynamic Young's modulus that was linear with flux. The observed rate of decrease indicated a negative bulk effect which was $-0.52 \pm 0.1 \times 10^{-3}/10^{16}$p/cm^2. Subsequent annealing revealed internal friction peaks around 10°K and 35°K. The latter peak is attributed to thermally activated residual dislocation damping and disappears as the dislocations are pinned by interstitials which migrate during recovery stage I_d. The peak at 10°K was observed in all polycrystalline samples and in single-crystal samples where the uniaxial stress was applied along a ⟨11⟩ direction. Single-crystal samples where the uniaxial stress was applied along a ⟨100⟩ direction failed to exhibit this peak. The peak was unaltered by annealing up to 25°K, but decreased upon annealing at higher temperatures. The temperature dependence and shape of the peak suggests stress-induced defect ordering having an activation energy of 0.015 ± 0.002 eV and an attempt frequency of $10^{11.2\pm1}$ sec^{-1}. It is believed that the peak results from the stress-induced reorientation of the interstitial member of an interstitial–vacancy close pair. (Diss. Abstr.)

6219 USE OF COMPUTER EXPERIMENTS TO PREDICT RADIATION EFFECTS IN REACTOR MATERIALS. Beeler, J. R. Jr. (North Carolina State Univ., Raleigh). Trans. Amer. Nucl. Soc., 12: 699(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6220 BASES AND INFLUENCES OF DIRECTIONAL CRYSTALLOGRAPHIC EFFECTS. Chadderton, Lewis T. (North American Rockwell Science Center, Thousand Oaks, Calif.). Trans. Amer. Nucl. Soc., 12: 699(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6221 REVIEW OF IRRADIATION-INDUCED VOID FORMATION IN METALS. Holmes, J. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 701(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6222 REVIEW OF FAST-NEUTRON RADIATION-DAMAGE PROBLEMS IN REACTOR MATERIALS. Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 699(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6223 PRESENT STATUS OF THE THEORY OF NEUTRON DAMAGE IN METALS. Robinson, Mark T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 699(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6224 TENSILE TESTING OF IRRADIATED EBR-II DRIVER FUEL CLADDING. Pearlman, H. (Atomics International, Canoga Park, Calif.); McCurnin, W. R.; Krupp, W. E. Trans. Amer. Nucl. Soc., 12: 583(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6225 TENSILE PROPERTIES OF FAST-REACTOR-IRRADIATED AISI TYPE-316 STAINLESS STEEL. Ward, A. L. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 584(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6226 EFFECTS OF NEUTRON IRRADIATION ON THE PLASTIC FATIGUE PROPERTIES OF STAINLESS STEEL. Moteff, J.; Smith, J. P.; Stapp, W. J. (General Electric Co., Cincinnati). Trans. Amer. Nucl. Soc., 12: 585(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6227 POSTIRRADIATION CREEP-RUPTURE PROPERTIES OF AISI TYPE-316 STAINLESS STEEL. Lovell, A. J. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 585-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6228 EFFECT OF FLUX LEVEL ON IRRADIATION-PRODUCED SWELLING. Murley, T. E. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 586-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6229 HELIUM GENERATION IN METALS IRRADIATED IN EBR-II. Hutchins, B. A.; Turner, J. E.; Busboom, H.; Comprelli, F. A. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 587-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6230 ANALYSIS OF SWELLING OF AUSTENITIC STAINLESS STEELS IN FAST REACTORS. Oldberg, S.; Sandusky, D.; Bohaboy, P. E.; Comprelli, F. A. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 588-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6231 RECENT OBSERVATIONS OF IRRADIATION-INDUCED VOID FORMATION IN AUSTENITIC STAINLESS STEELS. Bloom, E. E.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 589(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6232 KINETICS OF IN-PILE STRESS RELAXATION. Wolfe, R. A. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 589-90(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6233 MECHANISMS OF IRRADIATION CREEP IN ZIRCONIUM-BASE ALLOYS. Nichols, F. A. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 572-3 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6234 EVALUATION OF CREEP DEFORMATIONS IN PWR-1 BLANKET SHELLS. Larson, L. D.; Fong, J. T. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 573(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6235 APPROACH TO PREDICTING THE RADIATION-INDUCED SHIFT IN THE DUCTILE-BRITTLE TRANSITION TEMPERATURE. Wullaert, Richard A. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 573-4 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6236 STRESS RUPTURE AND FATIGUE PROPERTIES OF IRRADIATED TYPE-347 STAINLESS STEEL AT 650°C. Kangilaski, M.; Perrin, J. S.; Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 574-5 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6237 EFFECTS ON NEUTRON IRRADIATION OF THE MECHANICAL PROPERTIES OF MOLYBDENUM. Kingsbury, F. D.; Moteff, J. (General Electric Co., Cincinnati). Trans. Amer. Nucl. Soc., 12: 575(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6238 DOSE-RATE EFFECT ON YIELD STRENGTH OF NEUTRON-IRRADIATED STEEL. Serpan, Charles Z. Jr., Watson, Henry E. (Naval Research Lab., Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 576(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6239 EJECTION OF ATOMS FROM GOLD BY FAST AND THERMAL NEUTRONS. Verghese, K. (North Carolina State Univ., Raleigh). Trans. Amer. Nucl. Soc., 12: 544(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6240 CRYOGENIC TENSILE PROPERTIES OF IRRADIATED BERYLLIUM, TITANIUM, AND ALUMINUM ALLOYS. Coombe, J. R.; Shogan, R. P. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 545-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6241 ANALYSIS OF FAST-NEUTRON EFFECTS ON VOID FORMATION AND CREEP IN METALS. Harkness, S. D.; Poeppel, R. B.; Tesk, J. A.; Li, Che-yu (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 523(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6242 STABILITY AND GROWTH OF VOIDS IN IRRADIATED METALS. Bullough, R.; Eyre, B. L.; Perrin, R. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Amer. Nucl. Soc., 12: 523-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6243 EFFECTS OF FAST FLUX IRRADIATION ON THE MECHANICAL PROPERTIES AND DIMENSIONAL STABILITY OF STAINLESS STEEL. Claudson, T. T.; Barker, R. W. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 524 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6244 CRASH: A COMPUTER PROGRAM FOR THE EVALUATION OF THE CREEP OR PLASTIC BEHAVIOR OF FUEL PIN SHEATHS. Guyette, Michel (Societe Belge pour Industrie Nucleaire S.A., Brussels). Trans. Amer. Nucl. Soc., 12: 524-5 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6245 NEW CORRELATIONS INVOLVING THE LOW-CYCLE FATIGUE AND SHORT-TERM TENSILE BEHAVIOR OF IRRADIATED AND UNIRRADIATED 304 AND 316 STAINLESS STEEL. Conway, J. B.; Berling, J. T.; Stentz, R. H. (General Electric Co., Cincinnati). Trans. Amer. Nucl. Soc., 12: 525-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6246 REVIEW OF EVIDENCE FOR IRRADIATION DAMAGE FROM NEUTRON-CHARGED PARTICLE REACTIONS IN METALS. Bloom, E. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 701(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Ceramics and Cermets

Refer also to abstracts 6165 and 6166.

Corrosion and Erosion

Refer also to abstracts 6169 and 7116.

6247 COMPATIBILITY OF CARBIDE FUELS WITH POTENTIAL LMFBR CLADDINGS. Latimer, T. W.; Neimark, L. A.; Johnson, C. E.; Crouthamel, C. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 594-5(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Preparation and Fabrication

Refer also to abstracts 6180, 6262, and 7174.

6248 ELECTRICALLY CONDUCTIVE CERAMIC MATERIAL, METHOD OF FABRICATION AND APPLICATIONS. Anthony, Anne-Marie; Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,165,685. Oct. 1, 1969. Priority date Nov. 3, 1965, France.

Methods for the preparation and fabrication of electrically conductive ceramic materials are given. One ceramic material consisted of one or more rare earth metal chromites and/or yttrium chromite and tetragonal zirconium dioxide. Preferably 30 to 50% molar zirconium dioxide was used. Another type of ceramic material comprised, in addition to the above mixture, one or more rare earth oxides in a proportion of from 5 to 25% molar relative to the zirconium dioxide. These materials were fabricated into electric heating elements and magnetohydrodynamic generator electrodes. The electric conductivities at 1500 to 2100°K of different refractory materials having a zirconium dioxide base are given. (G.M.C.)

6249 SYNTHESIS AND FABRICATION OF CARBIDE FUELS. Leary, J. A.; Shupe, M. W.; Honnell, R.; Ogard, A. E. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 577-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6250 FABRICATION OF URANIUM–PLUTONIUM CARBIDES. Andersen, J.; Ridal, A.; Strasser, A. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 12: 578-9 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6251 PREPARATION OF CERAMIC-GRADE UO_2 FROM UF_6 BY A DIRECT CONVERSION PROCESS. Knudsen, I. E. (Westinghouse Electric Corp., Cheswick, Pa.). Trans. Amer. Nucl. Soc., 12: 437(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6252 FORMATION OF CARBIDE AND NITRIDE FUEL MATERIAL IN A SPRAY REACTOR. Coppinger, E. A.; Johnson, B. M. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 437-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6253 PREPARATION OF SOL-GEL SPHERES SMALLER THAN 200 MICRONS WITHOUT FLUIDIZATION. Haas, Paul A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 438-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6254 NEUTRON-PROTECTION MATERIAL. Lecrivain, Lucien; Mauny, Pierre; Vilnat, Jacqueline (to Commissariat a l'Energie Atomique). British Patent 1,169,851. 5 Nov 1969. Priority date 24 Jan 1967, France.

A design is given of a neutron-protection material composed of a vitreous product reduced to chips, grains, granules, or powders of less than or equal to 5 mm dia, alone or agglomerated by an hydraulic binder. The composition contains more than 29% of Be_2O_3, and SiO_2 and CaO, or Al_2O_3 and CaO, or Al_2O_3 and MgO. The most advantageous compositions are given in ternary diagrams. (J.C.W.)

6255 THE INVESTIGATION OF THE KINETICS OF THE REACTIONS OF OXIDES IN BeO–SiO_2. Bykovskii, V. S.; Dmitriev, I. A.; Semin, E. G. (Sverdlovsk Polytechnic Inst., USSR). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 194-5(Jan 1969). (In Russian).

The effects of the addition of small quantities (2% wt) of V_2O_5, ZnO, MnO_2, CoO, Fe_2O_3, and NiO on the kinetics of the reactions of BeO and SiO_2 were studied. Special attention was given to the purity of BeO and SiO_2, to even distribution of the added oxides, and to the avoiding of contamination of the materials. Specimens were annealed in silicon furnaces in air at 1000 to 1350°C and 1 to 40 hours. The specimens were studied by x radiation on a special apparatus with a copper anode and nickel filter. The degree of the formation of phenakite was determined by the relation of the annealing of the reacting mixtures and beryllium and silicon oxides. Heating to 1050°C for 40 hrs increased the end product yield of phenakite. X-radiation and thermographic analyses show that the reaction occurred between solid substances without passing into the liquid phase. It was found that additions of V_2O_5 resulted in low-melting solid solution V_2O_5 and BeO and the speed of the phenakite formation at 1050°C. (auth)

Properties Evaluations

Refer also to abstracts 5806, 5815, 5831, 6642, 6643, 6652, and 7126.

6256 (GEAP-12027) THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 7, February 1–May 1, 1969. Aitken, E. A.; Evans, S. K. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Aug 1969. Contract AT(04-3)-189. 11p. Dep. CFSTI.

The continuing work related to measurement of liquidus-solidus transformations, vaporization of urania and oxygen redistribution in a temperature gradient is presented. A possible mechanism for the appearance of a plutonium-to-uranium gradient in the high temperature regions of the fuel is presented and analyzed from existing thermodynamic data. The mechanism is based on preferential vaporization of uranium and plutonium species along a temperature gradient until a steady-state composition is achieved. (auth)

6257 (SC-T-69-1059) MECHANICAL PROPERTIES AT HIGH TEMPERATURES OF ULTRAREFRACTORY CARBIDES. Hivert, A.; Poulignier, J. Translated by Marcel I. Weinreich (Sandia Lab., Albuquerque, N. Mex.), from Rev. Hautes Temp. Refract.; 5: 55-61(1968). 13p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 31484.

6258 ELECTRIC CONDUCTIVITY OF ZrO_2–Nd_2O_3 SYSTEMS. Volchenkova, Z. S. (Sverdlovsk Inst. of Electrochemistry, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 1096-1102(Jun 1969). (In Russian).

ZrO_2–Nd_2O_3 systems exhibit mixed electric conductivity at temperatures from 500 to 1000°C. At 1000°C the electron component possesses a semiconducting hole character of P-type. Changes in total electric conductivity of ZrO_2–Nd_2O_3 systems are a function of the composition. The presence of minimum electric conductivity on isotherms of systems containing 33.3 Nd_2O_3 and 66.7 ZrO_2 mol % indicates the presence of the chemical compound $Nd_2Zr_2O_7$. Variation in the electric conductivity are accompanied by the formation of solid solutions. (tr-auth)

6259 EFFECT OF IMPURITIES ON THE DECOMPOSITION OF SOLID SOLUTIONS WITH A ZIRCONIUM DIOXIDE BASE. Gavrish, A. M.; Sukharevskii, B. Ya.; Zor, E. I.; Krivoruchko, P. P. (Ukrinian Scientific Research Inst. of Refractories, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 1103-6(Jun 1969). (In Russian).

X-ray studies were made of the effects of the impurities, Al_2O_3, TiO_2, and SiO_2, on the decomposition process in cubic solid solutions of ZrO_2 with 12 mol % of CaO, MgO, and Y_2O_3 after prolonged isothermal treatments at temperatures from 1200 to 2300°C. The impurities produced nonequilibrium three-phase solid solutions, bonded the stabilizing impurities in the chemical compounds, and accelerated the decomposition of the solid solutions. A more pronounced effect of impurities was observed with solutions of ZrO_2–MgO, and the most stable solutions contained ZrO_2–Y_2O_3. (tr-auth)

6260 THERMOLUMINESCENCE OF CaF_2–Er CRYSTALS. Batygov, S. Kh.; Voronko, H. K. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 1048-51 (Jun 1969). (In Russian).

The spectra of thermoluminescence and fluorescence of gamma-irradiated CaF_2–Er crystals vary with the concentration of Er. The reaction energy of $Er^{+2} \rightarrow Er^{+3}$ lies within the limits 2.3 to 3.9 eV. Studies were also made of the thermal oxidation of Er^{+2} in CaF_2–Er crystals. (tr-auth)

6261 MECHANICAL–PHYSICAL PROPERTIES OF HOMOGENEOUS ZIRCONIUM NITRIDE. Yanchur, V. P.; Andrievskii, R. A.; Spivak, I. I.; Fedotov, M. A. Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 1012-17(Jun 1969). (In Russian).

The density, electric conductivity, flexibility, Hall constant, magnetic susceptibility, melting point, microhardness, and modulus of normal elasticity of homogeneous zirconium nitride were studied. It was shown that these properties undergo continuous changes at temperatures from 1800 to 2250°C. (tr-auth)

6262 SINTERING BEHAVIOR OF SUBMICRON TUNGSTEN-THORIA POWDER BLENDS. Tardiff, George E. (Univ. of California, Livermore). Int. J. Powder Met.; 5: No. 4, 29-39 (Oct 1969).

A study of the sintering behavior of submicron tungsten-thoria (ThO_2) powder blends shows that severe coarsening of the thoria is associated with an activated sintering effect at remarkably low temperatures (~1100°C). This activation was observed during moist hydrogen sintering but in the cases of vacuum or ultra-high-purity hydrogen sintering. A tentative explanation offered for this behavior involves the formation of "liquid" type interparticle films associated with an interaction between thoria and a tungsten oxide derived from oxygen initially chemisorbed on the particle surfaces. (auth)

6263 EFFECT OF POROSITY ON THE THERMAL CONDUCTIVITY OF ThO_2. Murabayashi, Masayuki; Takahashi, Yoichi; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 6: 657-62(Nov 1969).

The effect of porosity on the thermal conductivity of sintered ThO_2 of densities ranging from 90 to 95% of theoretical density was investigated at 20°C. The thermal conductivity was determined by means of laser pulse. Discrepancies were observed between the experimental results and the relation derived by Loeb. This discrepancy was explained by applying a modified Maxwell formula derived by Brailsford et al. The samples were also examined metallographically. It is concluded that the existence of fluid continuous regions contribute significantly to the thermal resistance of such materials as ThO_2. (auth)

6264 REACTION OF BORONATED GRAPHITE WITH WATER VAPOR. Woodley, R. E. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Carbon, 7: 609-13 (Oct. 1969).

The reaction of boronated graphite with water vapor occurred by two consecutive reactions in the temperature range 830 to 930°, namely $B_4C + 6H_2O \rightarrow 2B_2O_3 + C + 6H_2$ and $B_2O_3 + H_2O \rightarrow 2HBO_2$. The rate of the first reaction decreased very rapidly initially with the formation of molten B_2O_3 on the surface of the sample. The influence of the second reaction was soon felt, however, and the rate of formation of B_2O_3 was balanced by its rate of removal as volatile HBO_2. During this steady-state condition, the rate of weight loss of the sample and the product H_2 concentration remained constant. (auth) (UK)

6265 VAPORIZATION OF URANIUM MONONITRIDE AND HEAT OF SUBLIMATION OF URANIUM. Gingerich, Karl A. (Battelle Memorial Inst., Columbus, Ohio). J. Chem. Phys.; 51: 4433-9(15 Nov 1969).

The vaporization of UN has been investigated by the Knudsen effusion technique in combination with a mass spectrometer. The vaporization occurs incongruently by preferential loss of nitrogen forming the two-phase system nitrogen-saturated liquid uranium–uranium-saturated nonstoichiometric uranium mononitride. The vapor pressures of U and N_2 have been obtained by silver calibration over the two-phase system $UN_{0.4}$–$UN_{0.9}$ in the temperature range 1910–2230°K. The enthalpies ΔH^0_{298} for the simplified reaction (1) UN(s) = U(g) + 0.5 N_2 (g) and its partial reactions (2) UN(s) = U(l) + 0.5 N_2(g) and (3) U(l) = U(g) have been obtained from second- and third-law treatments. The experimental third-law value of Partial Reaction (3) of 130.7 ± 2.2 kcal mole^{-1} may be considered an upper value for the heat of vaporization of uranium metal. The third-law enthalpy of Partial Reaction (2) of 68.9 ± 0.4 kcal mole^{-1} is in the general agreement with literature data for this reaction. The selected value for the enthalpy of Reaction (1) of ΔH^0_{298} = 200.3 ± 4.0 kcal mole^{-1} yields with appropriate literature data a heat of atomization ΔH^0_{298} = 313.3 ± 4.5 kcal mole^{-1} for solid UN, and a heat of vaporization ΔH^0_{298} = 127.9 ± 4.9 kcal mole^{-1} for uranium. The difference of 2.8 kcal mole^{-1} between this value and the directly measured value for Partial Reaction (3) is attributed to an activity decrease of uranium in nitrogen-saturated liquid uranium that is in equilibrium with the UN phase. (auth)

6266 MAGNETOTHERMAL OSCILLATIONS IN PRESSURE-ANNEALED PYROLYTIC GRAPHITE. Flood, D. J. (Lewis Research Center, Cleveland). Phys. Lett., 30A: 178-9(Oct. 6, 1969).

Magnetothermal oscillations have been observed in pressure-annealed pyrolytic graphite. The period of the oscillations was measured as a function of angle between magnetic field H and the c axis of the crystal. The sample had a resistance ratio of ½ from room temperature to 4.2°K. Data were obtained for the majority hole carriers into the extreme quantum limit. (auth)

6267 VAPORIZATION OF NITRIDE AND CARBIDE FUELS. Alexander, C. A.; Ogden, J. S.; Pardue, W. M. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 581-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6268 FUNDAMENTAL PROPERTIES OF UN. Fulkerson, W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 591(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6269 THERMAL CONDUCTIVITY OF URANIUM–PLUTONIUM CARBIDES. Johnson, K. W. R.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 591-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6270 MECHANICAL PROPERTIES OF CARBIDE AND NITRIDE REACTOR FUELS. Tokar, M.; Nutt, A. W.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 592-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6271 PLUTONIUM MIGRATION IN A THERMAL GRADIENT IN MIXED (U,Pu) OXIDE FUELS. Bober, M. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.); Sari, C.; Schumacher, G. Trans. Amer. Nucl. Soc., 12: 603(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6272 RECOMMENDED EXPRESSION FOR THE SOLUBILITY OF OXYGEN IN LIQUID SODIUM. Eichelberger, R. L. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 613-14(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6273 THE EFFECT OF ADDITIONS OF STRONTIUM OXIDE ON THE KINETICS OF U_4O_9 REDUCTION BY HYDROGEN. Vlasov, V. G.; Pis'menko, V. T.; Larin, A. A. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 102-7(1969). (In Russian).

The effect of homophase additions of SrO on the kinetics of hydrogen reduction of U_4O_9 was studied and showed that the relation between the rate of reduction and the quantity of addition is very complex. The presence of SrO additions does not affect the apparent energy of activation. In all cases, it was equal to 23 ± 3 kCal/mol. An increase in impurity quantities from zero to 1 mol. % (in calculating $UO_{2.25}$) resulted in a decrease in the crystalline lattice parameter. A further increase in the quantity of impurities caused little or no increase in the lattice parameter. (tr-auth)

6274 ENERGY DETERMINATION OF ELECTRON-VOID FORMATION IN CdSe MONOCRYSTALS EXCITED BY 10 TO 50 keV ELECTRONS AND BY LIGHT IN THE ULTRAVIOLET SPECTRUM. Kudykina, T. A.; Fedorus, G. A.; Fursenko, V. D.; Sheinkman, M. K. (Inst. of Semiconductors, Kiev). Fiz. Tekh. Poluprov.; 3: 526-30(Apr 1969). (In Russian).

The energy of separation of electron-void pairs in CdSe monocrystals during electron excitation with energies from 10 to 50 keV and light excitation in the ultraviolet spectrum was measured. The measurement method was based on comparison of the photoconductivity and conductivity induced by electron excitation with measurement of the spectral distribution of photo current in the ultraviolet spectrum for the same crystal. The E_v values obtained by both electron and ultraviolet excitation were identical. (tr-auth)

6275 ELECTRIC PROPERTIES OF CARBIDES OF GROUP IV TRANSITION METALS. Golikova, O. A.; Dzhafarov, E. O.; Avgustinik, A. I.; Klimashin, G. M. (Inst. of Semiconductors, Leningrad). Fiz. Tekh. Poluprov.; 3: 506-10(Apr 1969). (In Russian).

The electric conductivity, thermal emf, and Hall coefficient of the carbides of hafnium, titanium, and zirconium as a function of carbon content were studied. The electric conductivity was found to increase with an increasing number of carbon vacancies. The

influence of metallic and nonmetallic impurities on the electric properties of carbides was studied and showed that the mobility of electrons is determined only by their abundance and does not depend on the presence of lattice defects. Electric conductivities and thermal emf's were measured at temperatures from 20 to 2200°C. At temperatures from 1500 to 2200°C, thermal emf begins to decrease with increasing temperature and the amount of the emf drop is more pronounced with a decrease in concentration of current carriers. The electric conductivity remains constant or increases with an increase in temperature. (tr-auth)

6276 THE BEHAVIOR OF $MoSi_2$, WSi_2, AND $TaSi_2$ IN VACUUM AT HIGH TEMPERATURES. Ivanov, V. E.; Nechiporenko, E. P.; Krivoruchko, V. M.; Patokin, A. P.; Poltavtsev, N. S. (Inst. of Physics and Tech., Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 8-14(Jan 1969). (In Russian).

The behavior of many materials at high temperatures depends on the method of their preparation, the purity of the material, stoichiometric composition, and other factors. The behavior of the disilicides of molybdenum, tantalum, and tungsten, obtained by the vacuum diffusion method was studied. It was found that $MoSi_2$, $TaSi_2$, and WSi_2 at 1400 to 1700°C disintegrate in a vacuum by means of the evaporation of silicon and transition, which finally goes over to the metal. The decomposition formulas are given. The decomposition of the disilicides occurs by means of evaporation of silicon, and not by silicides molecules. At 1400 to 1700°C the rate of variation of weight of the specimen was determined by the rate of the diffusion of silicon. The stability of the disilicides in vacuum at 1400 to 1700°C was determined. The stability of the silicides in vacuum increased from disilicides towards lower silicides. (tr-auth)

6277 CERTAIN PHYSICAL–CHEMICAL PROPERTIES OF COMBINED PRECIPITATED HYDROXIDES OF HOLMIUM AND ZIRCONIUM AND HOLMIUM AND HAFNIUM. Belyaev, I. N.; Artamonova, S. M. (Rostov State Univ., USSR). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 93-5(Jan 1969). (In Russian).

Precipitates were obtained by the combined precipitation of the hydroxides of holmium and zirconium and holmium and hafnium in the ratio of 1 to 1. Thermographic studies and weight losses during heating showed that the precipitates are not simple mechanical mixtures of hydroxides of holmium and zirconium and holmium and hafnium. X-ray analysis confirmed that after dehydration of the coprecipitated hydroxides, holmium and zirconium, holmium and hafnium formed corresponding zirconates and hafnates, $Ho_2Zr_2O_7$ and $Ho_2Hf_2O_7$, with a cubic elementary cell with parameters of 10.38 and 10.40 Å respectively. (tr-auth)

Structure and Phase Studies

Refer also to abstracts 6271, 6650, and 6662.

6278 EFFECT OF WORKING DIRECTION ON THE MICROSTRUCTURE AND HIGH-TEMPERATURE MECHANICAL PROPERTIES OF AN EXTRUDED SAP ALLOY. Nilsson, T. M. (Oak Ridge National Lab., Tenn.). Int. J. Powder Met.; 5: No. 4, 43-56(Oct 1969).

Bars of commercial SAP 895 containing about 10.5 wt % aluminum oxide were further worked transverse and parallel to the initial extrusion direction. At higher transverse reductions the structure became realigned into the new working direction and both strength and ductility exceeded significantly the original extruded values; noteworthy was the more than doubled uniform elongation after transverse swaging 30:1. (auth)

6279 A D.T.A. STUDY OF THE SEMICONDUCTOR-METALLIC TRANSITION TEMPERATURE IN $V_{1-x}W_xO_2$, $0 \leq x \leq 0.067$. Nygren, M.; Israelsson, M. (Univ. of Stockholm). Mater. Res. Bull.; 4: 881-8(Dec 1969).

A simple low-temperature DTA set-up, designed for measurements in the temperature region 120°to 600°K, is described. The system $V_{1-x}W_xO_2$, $0 \leq x \leq 0.067$, has been studied by means of DTA and x-ray powder diffraction methods. A linear decrease of the transition temperature with increasing x has been observed. (auth)

6280 ELECTRONIC CONDUCTION IN CRYSTALLINE AND NONCRYSTALLINE OXIDES CONTAINING VANADIUM. Kennedy, Thomas N. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 360p.

Thesis.

In this investigation, homogeneous glasses in the system V_2O_5, P_2O_5; V_2O_4, P_2O_5; V_2O_5 (V_2O_4, V_2O_3), CaO, P_2O_5 (B_2O_3) were obtained. The electrical resistivity of all glasses increased with increasing concentration of transition metal oxide. From chemical analysis, the vanadium ions in glasses based on V_2O_5 existed as V^{5+} and V^{4+} as was the case for the $V_2O_4 \cdot P_2O_5$ glasses. Thermoelectric power measurements varied logarithmically with hi-low valence ratio of the vanadium ions and agreed well with the chemically determined valence state concentrations. It was found to be difficult to prepare glasses with large amounts of V_2O_3 and V_2O_4 in which the vanadium ions exist in the 3+ and 4+ states. Therefore amorphous thin films of V_2O_3 and V_2O_4 were prepared by radio-frequency sputtering, and were shown to be noncrystalline by x-ray analysis and diffraction. These amorphous films were semiconducting in the temperature range from −196°C to 175°C. The semiconductor–metal transition characteristic of crystalline V_2O_3 and V_2O_4 was not observed in the amorphous films, and, depending on the deposition temperature of the substrate during sputtering, amorphous films were prepared having markedly different resistivities. V_2O_4 films deposited above the transition temperature had resistivities of about three orders of magnitude lower than those deposited below the transition temperature. It was not possible to get V_2O_3 films deposited below the transition temperature. The V_2O_4 films were crystallized and exhibited two very strong x-ray diffractometer peaks which corresponded to the two main peaks (i.e., (011) and (012)) of the V_2O_4 powder pattern. The crystallized films showed a discontinuity in the electrical resistivity at 66°C. Upon heating through the transition temperature the resistivity dropped by a factor of 10^3, but the films were semiconducting both above and below the transition. Both amorphous and crystallized V_2O_4 films were n-type semiconductors as evidenced by the small negative thermoelectric power, indicating the existence of V^{3+}. The thermoelectric power changed little in the temperature range 25–200°C, i.e., there was no transition in the thermoelectric power of crystallized V_2O_4 films. V_2O_3 films were p-type semiconductors as shown by the small positive thermoelectric power indicating the presence of V^{4+} ions. The thermoelectric power was constant in the temperature range 25–200°C. Conventional semiconducting oxide glasses were also sputtered to form thin amorphous films of glasses prepared from the melt. It was observed that the properties of the amorphous films differed little from the conventionally cast glasses of the same composition. (Diss. Abstr.)

6281 PHASE TRANSFORMATIONS IN BORON NITRIDE CAUSED BY DYNAMIC COMPRESSION. Dulin, I. N.; Al'tshuler, L. V.; Vashchenko, V. Ya.; Zubarev, V. N. Sov. Phys.-Solid State (Engl. Transl.); 11: 1016-20(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1252-7(May 1969).

A study was made of a polymorphic transition in boron nitride at high pressures of 60–500 kbars. Samples of the hexagonal form of boron nitride were compressed for short intervals of time (~10 μsec). After compression, the undamaged samples were subjected to an x-ray phase analysis. In addition to pressure, the initial density and temperature of the sample were varied. The concentrations of the cubic and wurtzite modifications in the original samples depended on the density and temperature and ranged from 0 to 80%. Shock compression at 100 kbars or less did not produce the dense phases. At 120 kbars, the strongest dependence of the yield of new phases on the initial state of the sample was observed; this was attributed to the dynamic features of the phase transition. All the results obtained at higher pressures (P > 200 kbars) suggested that a practically complete transition of the hexagonal modification into the cubic and wurtzite phases was most likely in this range of pressures. The existence of the original modification in the compressed samples was attributed to a reverse transition of boron nitride during cooling. (auth)

6282 THE UO_2–Fe_2O_3 AND PuO_2–Fe_2O_3 SYSTEM IN AIR. Riley, B. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 543-4(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6283 PHASE RELATIONS IN THE U–Pu–C–O–N SYSTEM. Blickensderfer, Robert; Henry, Jack L. (Bureau of Mines, Albany, Oreg.). Trans. Amer. Nucl. Soc., 12: 580-1(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6284 THE SYNTHESIS, CRYSTAL STRUCTURE, AND SUPERCONDUCTING PROPERTIES OF NIOBIUM PHOSPHORUS SULFIDE, NIOBIUM PHOSPHORUS SELENIDE, AND TANTALUM PHOSPHORUS SULFIDE. Donohue, P. C.; Bierstedt, P. E. (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). Inorg. Chem.; 8: 2090-4(Dec 1969).

The new ternary compounds NbPS, NbPSe, and TaPS were prepared by reaction of the elements in 1:1:1 atomic ratio in a tetrahedral anvil press at 1200° and 65 kbars. The compounds are isostructural, with orthorhombic cells and space group Immm.

The cell dimensions at 1 atm and 25° are: for NbPS, a = 3.438 ± 0.002 Å, b = 11.88 ± 0.01 Å, c = 4.725 ± 0.002 Å; for NbPSe, a = 3.462 ± 0.002 Å, b = 12.33 ± 0.01 Å, c = 4.821 ± 0.005 Å, for TaPS, a = 3.430 ± 0.005 Å, b = 11.85 ± 0.01 Å, c = 4.728 ± 0.005 Å. The crystal structures of NbPS and NbPSe were solved from x-ray powder diffraction data by the use of three-dimensional Patterson and least-squares refinement techniques. The R factors, based on F^2, were reduced to 0.093 for NbPS and 0.086 for NbPSe. The coordination around each Nb is a bicapped trigonal prism comprised of four P and four S(Se) atoms. These share faces in pairs through the four P atoms with 2.93 ± 0.02 Å between the Nb atoms. The P atoms are paired at 2.21 ± 0.05 Å in NbPS and 2.13 ± 0.04 Å in NbPSe. Solid solutions have been prepared in the systems $Nb_{1-x}Ta_xPS$ and $NbPS_{1-x}Se_x$ where $1 > x > 0$. All compounds show metallic behavior, and NbPS is superconducting with the maximum T_c = 12.5°K. NbPSe and TaPS do not show superconductivity down to 1.25°K. (auth)

6285 ON THE FORMATION OF CUBIC SOLID SOLUTIONS OF FLUORITE-TYPE STRUCTURE ZrO_2–Y_2O_3 SYSTEM. Zubankov, V. N.; Strekalovskii, V. N.; Pal'guev, S. F. (Inst. of Electrochemistry, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 88-92(Jan 1969). (In Russian).

High-temperature roentgenography of the system 0.93 ZrO_2–0.07 Y_2O_3 at 1400°C was used to study the process of formation of fluorite-type solid solution Y_2O_3 in ZrO_2. It was found that the formation of fluorite solid solution takes place at temperatures above 1100°C. The rate of the process is increased significantly at temperatures when the process of the monoclinic-tetragonal transformation of ZrO_2 is completed. (tr-auth)

Radiation Effects

Refer also to abstracts 7120, 7125, 7184, 7209, 7309, 7310, 7346, 7353, 7359, 7360, 7361, and 7373.

6286 (UCRL-50727) HIGH-TEMPERATURE IRRADIATION AND POST-IRRADIATION ANALYSIS OF URANIUM NITRIDE FUEL. Albrecht, E. D.; Rothman, A. J.; Lee, J. D.; Johnson, J. M.; Hayes, W. N. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). 7 Aug 1969. 39p. Dep. CFSTI.

A fission-heated, gas-bonded, binary-gas-controlled irradiation capsule containing eight uranium nitride specimens was irradiated in the Battelle Research Reactor for eight cycles. The median specimen temperature ranged from 1307 to 1417°C during the irradiation, and the average burnup was 2.3×10^{20} fissions/cc. Two specimens each of four different microstructures, including fine-grain (30 μ), 96% dense; coarse-grain (105 μ), 97% dense; single-crystal, 100% dense; and fine-grain (30 μ), 78% dense fuel were irradiated for a total of 3558 hr. The 9.6% enriched specimens were nominally 0.750 in. in length and 0.200 in. in outside diameter and had a 0.100-in.-diam axial hole. Each specimen was composed of from one to three segments; the lower segment of the single-crystal specimens was an undrilled, solid piece. The fuel specimens were clad in vented W-25.5Re that had a wall thickness of 0.020 in. To prevent decomposition of the uranium nitride, a partial nitrogen pressure was maintained during the irradiation by the external heating of U_2N_3 powder located at the bottom of the capsule. Neutron radiographs were made of the capsule before irradiation and at the conclusion of each cycle in an attempt to acquire progressive swelling data during the irradiation. The only significant changes observed in the microstructure after irradiation were the creation of fine porosity at the grain boundaries of all polycrystalline specimens and the preferential alignment of this porosity in those grain boundaries lying parallel to a specimen surface. The single-crystal specimens did not exhibit this porosity except for rare occurrences along subgrain boundaries near the surface. Analyses of retained fission gas by mass spectrometric techniques showed that nearly 100% of the fission gas generated was retained in each specimen, regardless of microstructure. The fine-grain (30 μ), 96% dense UN swelled the greatest amount at 1417°C and to a lesser extent at 1307°C, revealing an implied temperature dependence. The fine-grain (30 μ), 78% dense and single-crystal, 100% dense UN showed the least swelling under the conditions of this irradiation. (auth)

6287 COMPATIBILITY OF MIXED NITRIDES WITH LMFBR CLADDINGS. Hebeisen, J. C.; Moak, D. P.; Saling, J. H. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 595-7(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6288 AXIAL RATCHETTING OF FUEL RODS UNDER POWER AND PRESSURE CYCLING CONDITIONS (LWBR DEVELOPMENT PROGRAM). Duncombe, E.; Goldberg, I. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 526-7(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6289 IRRADIATION OF URANIUM–PLUTONIUM CARBIDES. Strasser, A.; Montgomery, M. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 12: 597-8(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6290 IRRADIATION PERFORMANCE OF (U,Pu)N. Bauer, A. A.; Saling, J. H.; Storhok, V. W. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 598-9(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Plastics and Other Materials

Refer also to abstract 6166.

6291 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF IRRADIATED CALCIUM-ALUMINATED GLASS. Yanishevskii, V. M.; Sidorov, T. A.; Tyulkin, V. A. Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 1159-60(Jun 1969). (In Russian).

The electron paramagnetic resonance spectra of irradiated calcium-aluminated glasses doped with various alkaline oxides were studied at temperatures from 1400 to 1520°C. (tr-auth)

6292 ACCELERATED AGING OF FIBERGLASS PLASTIC PREPARED BY RADIATION AND THERMOCHEMICAL METHODS. Osnach, N. A.; Omel'chenko, S. I.; Krivitskaya, G. N.; Videnina, N. G.; Shchepetkina, N. I.; P'yankov, G. N.; Chervetsova, I. N. (Inst. of Chemistry of High Molecular Compounds, Kiev). Khim. Prom., No. 2, 3-4(Mar.-Apr. 1969). (In Russian).

The effects of the atmospheric aging of fiberglass plastic obtained by irradiation are compared with that of fiberglass hardened in the presence of the most popular initiating systems, e.g., benzoyl peroxide and isopropylbenzene hydroperoxide with cobalt naphthenate. The photochemical aging of the samples was investigated under laboratory conditions under the action of light emitted by PRK-2 type fluorescent lamps. The tests were performed in an IP-1 artificial weather apparatus. The aging process was judged from changes in ultimate static bending strength and the appearance of the fiberglass plastic. It was found that the fiberglass plastic crosslinked by radiation possessed higher atmospheric resistance than the fiberglass plastic obtained thermochemically. Irradiation for 1000 hours in the weatherometer produced no changes in the properties of the radiation samples, while causing a 30 to 33% decrease in the strength of the fiberglass plastic samples hardened in the presence of peroxide initiators. (JPRS)

6293 INVESTIGATION OF RADIATION CENTERS IN QUARTZ GLASS BY ELECTRON PARAMAGNETIC RESONANCE. Sidorov, T. A.; Tyul'kin, V. A. Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 58-62(Jan 1969). (In Russian).

Glass was irradiated by neutrons and gamma radiation at 293°K and by x rays at 77 and 293°K. It was established that two types of centers appear in quartz glass: electron, which was captured by silicon atoms; and vacancy with the oxygen in the hydroxyl group. In the irradiated forms of crystalline and fused quartz containing impurities, vacancies developed on non-bridged atoms of oxygen, bound to atoms of silicon. The EPR lines and the band of optical absorption are reduced to definite vacancies and electronic centers. (tr-auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Cosmic Ray Exposure Ages

6294 ALLENDE METEORITE: SOME MAJOR AND TRACE ELEMENT ABUNDANCES BY NEUTRON ACTIVATION ANALYSIS. Morgan, J. W.; Rebagay, T. V.; Showalter, D. L.; Nadkarni, R. A.; Gillum, D. E.; McKown, D. M.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Nature (London); 224: 789-91(22 Nov 1969).

This meteorite, which fell on Feb. 8th 1969, was of the relatively rare carbonaceous chondrite type. It is suggested that enough material is available from this body to serve as a source of a "standard meteorite" powder. It is felt that many of the abundance discrepancies in meteorite literature may have been due to sampling inadequacies, and it is suggested that one of the institutions holding a large amount of the Allende fall might consider preparation of a homogenised powder in sufficient amounts to provide for meaningful interlaboratory comparisons. Analytical figures are given for 14 elements in homogenised powders derived from three Allende stones; these elements cover a wide range of geochemical affinities, and comprise Si, O, Ni, Na, Co, Ir, Zr, Hf, Au, Pt, Fe, Cr, Sc, and W. The neutron activation analytical technique was employed. The abundances found for the strongly siderophilic elements such as Ni, Co, Ir, Au, and Pt were among the highest reported for carbonaceous chondrites, and these elements were present mostly in mineral form. Comparisons are made with the Mokoia and other meteorites. (UK)

Stars

6295 THE PLANETARY NEBULAE. VIII. Aller, Lawrence H. (Univ. of California, Los Angeles). Sky Telesc.; 38: 377-9(Dec 1969).

In parts VI and VII, the classification of planetary nebulae was surveyed, and models were considered to explain their observed forms and internal motions. Here an attempt is made to obtain some understanding of how the planetaries came into being and why they have their present forms. (W.D.M.)

6296 NATURE OF THE BETA CEPHEI STARS: AN OBSERVATIONAL AND THEORETICAL STUDY. Percy, John Rees. Toronto; Univ. of Toronto (1968).

Thesis.

Intensive photometric studies of about 25 suspected β Cephei stars have shown that i) statistical methods for detecting short-period variability in stars can easily produce spurious or non-existent periods, under practical conditions. This applies to several new variables discovered recently by Hill; ii) only 3 of 12 stars, suspected of β Cephei variability on the basis of variable spectral line appearance, actually belong to this class; iii) the β Cephei instability strip terminates, at its faint end, very close to $M_v = -3.0$. Improved masses, radii, and chemical composition parameters have been derived indirectly for the β Cephei stars, and new values for the rate of period change have been derived for several of them. Interior and envelope models have been constructed, using improved opacities, and the pulsation periods of these models have been calculated. Comparison of these periods with the observed ones indicates that the β Cephei stars are pulsating in the second radial overtone. Van Hoof's theory of the origin of the beat phenomenon in these stars is still valid. (TSS) (Diss. Abstr.)

6297 EFFECTS OF HYPERONS ON VIBRATIONS OF NEUTRON STARS. Langer, William David. New Haven; Yale Univ. (1968). 129p.

Thesis.

The effects of hyperons and resonance particles on the vibrations of neutron stars are calculated. Vibrating neutron stars can store large amounts of energy in their vibrations; the interaction of the vibrations with the atmosphere would produce electromagnetic radiation. If any process damps out the vibrations rapidly on an astronomical time scale then vibrating neutron stars will not be found and one must look at other phenomena for observation. Previous work indicates that radiation by a neutrino URCA process ($N + N \rightarrow P + N + e^- + \bar{\nu}_e$) does not rapidly damp many of the neutron star models. Thermal damping by nonequilibrium reaction rates of the massive baryons is studied. The first two massive baryons to appear are the Σ^- and Δ^-. Their reactions are studied where conservation of energy and momentum can be satisfied at the top of the Fermi sea. The Σ^- reaction $N + N \rightarrow P + \Sigma^-$ is considered. The transition matrix, $|M|$, is calculated using a current current interaction where the currents are described by Cabibbo's SU(3) model. Next, $|M|$ for $N + N \rightarrow P + \Delta^-$ is calculated using a modified one pion exchange model. Combining $|M|^2$ with the solution for the phase space available in a degenerate gas with varying Fermi levels, the reaction rates are obtained. The damping is calculated by following a pressure–volume, PV, diagram through a cycle for a sample volume. For reactions fast or slow compared to the vibrational frequency, the gas stays near equilibrium and very little work is done. The Σ^- reacts by a weak interaction through a finite layer in the star's core and the rates are such that damping is rapid; the Δ^- rates are much faster and do not contribute to damping. The damping rate is used to follow the vibrational energy of a neutron star as a function of time. It is found that neutron stars with hyperon cores cannot sustain vibrations for astronomical times (1000 years). (Diss. Abstr.)

6298 OH EMISSION AND THE INFRARED STAR IN VY CANIS MAJORIS. Booth, R. S. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London); 224: 783-4(22 Nov 1969).

Infrared stars, which are apparently cool objects and are often immersed in dust, are found to be sources of OH radio line emission. The OH emission is usually concentrated in the satellite line at 1612 MHZ, with little or no emission at the main-line frequencies 1665 and 1667 MHZ or at 1720 MHZ. The 1612 MHZ emission is unpolarized and typically concentrated in two separated velocity regions. Measurement of the line emission from VY C Ma, however, has shown that is is a strong emitter at 1665 and 1667 MHZ, and that it is also variable. These observations were made with the Mark II radio telescope at Jodrell Bank in May 1969. The spectrum at 1665 MHZ was predominantly left hand circularly polarized, while that at 1667 MHZ was mainly right hand. An interesting feature of these spectra is the close velocity coincidence of several lines at the two main frequencies. Further spectra were obtained in Aug. 1969, and large changes were apparent in the relative intensities of several features. There was no evidence of continuum emission of 5 flux units at 18 cm. The radiation at 1665 and 1667 MHZ appears to be associated with the infrared star itself and not with an H II region. (UK)

6299 THE COMPOSITION AND AGE OF δ PAVONIS. Rodgers, A. W. Mon. Notic. Roy. Astron. Soc.; 145: 151-62(1969).

The temperature of δ Pav, G8 V, an old disc population star, was determined using hydrogen line profiles and near infrared photometry. It is found that δ Pav suffers excess line blanketing for its temperature, which is only 100°K cooler than the Sun. A differential curve of growth analysis of the composition of δ Pav reveals that it has the same metal/hydrogen ratio as the Sun and that the excess line strengths are predominantly the result of a higher microturbulent velocity. Use of the derived effective temperature and well determined trigonometric parallax of δ Pav leads to an estimate of its age as $(8 \pm 3) \times 10^9$ yr, i.e., it was formed at an epoch between the formation of NGC 188 and M67. (auth) (UK)

6300 RADIATIVE EXCITATION IN PLANETARY NEBULAE. Van Blerkom, D. Mon. Notic. Roy. Astron. Soc.; 145: 75-90 (1969).

The recombination spectra of hydrogen and helium from several planetary nebulae and the Orion nebula cannot be explained by recombination theory in its present form. The possibility that the deviations of the relative line intensities from theory are caused by direct photoexcitation of ground state atoms through absorption of stellar resonance line photons is investigated. The transfer equations for Lyman line and continuum radiation are solved in nebulae of different thicknesses by means of the normalized on-the-spot (NOS) approximation which is discussed. When the central star radiates as a black body at all frequencies, the Balmer decrements are found to differ only slightly from those predicted by recombination theory under optically thick (case B) conditions. By inverting the problem, the spectral energy distribution of the central star which produces the observed intensities of the nebula emission lines is found. The distribution obtained has a discontinuity at the Lyman limit such that there is more energy emitted at frequencies below the limit than at those above. This distribution is not plausible, and it is concluded that radiative excitation is not responsible for the anomalous intensities. Several other physical processes—interstellar reddening, absorption by neutral hydrogen atoms in an H I region, and stimulated recombination by infrared radiation—are briefly considered as possibly affecting the Balmer decrements, but are ruled out. Finally, an apparent inconsistency in the observational data is discussed, which indicates that the Paschen lines from objects with anomalous Balmer decrements are normal. (auth) (UK)

6301 SOME GENERAL RELATIVISTIC INEQUALITIES FOR A STAR IN HYDROSTATIC EQUILIBRIUM. Islam, Jamal N. Mon. Notic. Roy. Astron. Soc.; 145: 21-9(1969).

A minimal theorem for the pressure inside a star in hydrostatic equilibrium is obtained in general relativity that is the analogue of a well-known classical theorem. An improvement is made on some limiting inequalities obtained by Buchdahl (1959) related to the gravitational potential energy. (auth) (UK)

6302 ALLEGED SUPERNOVA OF AD 1006. Botley, C. M. (Turnbridge Wells, Eng.). Nature (London); 224: 891(29 Nov 1969).

It is stated that recent further information throws doubt on the identification of this object with χ Lupi (see Nature 222: 649 (1969)). (UK)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 6332.

6303 ACCURATE DECLINATIONS OF 32 RADIO SOURCES. Brooks, Clinton Childs. New Haven; Yale Univ. (1968). 149p.

Thesis.

The general theory of a broadband interferometer is developed, and the potential sources of errors are discussed. A specific lowpass single sideband instrument constructed to conform to this theory is described; it has a nominal rf operating center frequency of 245 MHz and a 20 MHz bandwidth centered at a nominal IF frequency of 60 MHz. Two observing programs, one near the zenith, the other at zenith distances up to 50°, were undertaken to test the limitations of the instrument. The techniques of data analysis are described in detail, and the final results of declination positions with internal rms errors ranging from 0.5 arc-second to 4 arc-seconds are presented. In conclusion, the potential of this new interferometer is examined. (Disser. Abstr.)

6304 A PENCIL-BEAM SURVEY OF RADIO SOURCES AT 178 MHz. Caswell, J. L.; Crowther, J. H. Mon. Notic. Roy. Astron. Soc.; 145: 181-96(1969).

A sample region of the sky surveyed by the 4C interferometer was observed by a pencil-beam instrument at the same frequency. Flux densities are given for 726 sources, 640 of which are contained in the 4C catalogue. In addition to listing some new sources with angular sizes greater than a few minutes of arc, the present results are compared with the 4C interferometer data to derive an upper limit for the number of sources omitted from the 4C catalogue due to partial resolution; the comparison also shows that the proportion of sources in the 4C catalogue whose flux densities are seriously underestimated (low by more than 30%) is about 7%. (auth) (UK)

6305 ESTIMATE OF THE GRAVITATIONAL RADIATION FROM NP 0532. Meloak, H. J. (Hughes Research Labs., Malibu, Calif.). Nature (London); 224: 781-2(22 Nov 1969).

The gravitational radiation to be expected from the pulsar NP 0532 (the Crab Nebula pulsar) is estimated on the basis of the oblique rotator model, which postulates that pulsars are rotating neutron stars with a frozen-in magnetic field, and the axis of the magnetic field is skewed with respect to the axis of rotation. The presence of a very strong magnetic field will tend to distort the shape of the neutron star, and a dipole magnetic field will result in a flattening of the surface of the star in the region of the magnetic poles. In the case of the oblique rotator model this flattening is asymmetric with respect to the axis of rotation, leading to a star with a time-dependent quadrupole movement. The star would therefore be expected to be a source of gravitational radiation. The degree of flattening to be expected can be estimated with the help of a calculation due to Ferraro (Astrophys J. 119: 407(1954)), and it may be assumed that the time-dependent quadrupole movement may be calculated approximately from the model of an oblate spheroid rotating about an axis not coinciding with its short principal axis. The weak field approximation to general relativity is then applied to give the average power emitted in the form of gravitational waves, and a proportionality is arrived at between the gravitational and electromagnetic radiation rates. The range in intensity of the gravitational radiation from NP 0532 is then found to lie within 8×10^{32} and 8×10^{33} ergs/sec. The expected flux of gravitational radiation on the Earth is calculated as 2×10^{-12} to 2×10^{-11} ergs/cm^2/sec. (UK)

6306 OBSERVATION OF A NEW X-RAY SOURCE. Kitamura, T.; Matsuoka, M.; Miyamoto, S.; Nakagawa, M.; Oda, M.; Ogawara, Y.; Takagishi, K. (Tokyo Univ.). Nature (London); 224: 784-5(22 Nov 1969).

A new cosmic strong x-ray source was observed near Sco X-1 during rocket flights on Aug. 7, 1969. The instrument employed comprised two Xe–methane-filled proportional counters. The position of the source was estimated as $\alpha = 14\text{h } 55\text{m} \pm 10\text{m}$, $\delta = -32 \pm 3°$. The spectrum was similar to that of Sco X-1, and the x-ray intensity in the energy range 2 to 25 keV was 44 photons/cm^2/sec. The source seems to resemble Cen X-2, which shows a nova-like behavior, and would seem to fall in the Sco X-1 exponential spectrum category. The source may be that reported by Conner et al. in July, 1969. (UK)

6307 COSMIC X-RAY OBSERVATIONS. Friedman, H. (Naval Research Lab., Washington, D. C.). Proc. Roy. Soc. (London), Ser. A; 313: 301-15(11 Nov 1969).

Observational studies of cosmic x-ray sources are reviewed under the following headings: Introduction; discrete sources (Taurus XR-1, Sco XR-1, Cygnus XR-1, Cygnus XR-2, Vulpecula XR-1, Centaurus XR-2); polarization and line emission; x-ray galaxies; the diffuse background. 53 references. (UK)

6308 A MECHANISM FOR X-RAY PRODUCTION IN SCO X-1. Manley, O. P. (American Science and Engineering, Cambridge, Mass.). Proc. Roy. Soc. (London), Ser. A; 313: 395-402(11 Nov 1969).

Some recent studies on the mechanism of x-ray production in "extars" are summarized, with special emphasis on Sco X-1. 11 references. (UK)

6309 PRIMORDIAL COSMIC RAY SOURCES. Stecker, F. W. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London); 224: 870-2(29 Nov 1969).

New gamma-ray observations have provided what may be evidence for primordial cosmic-ray sources existing out to redshifts of the order of 100. These sources may be galaxies and quasars in their initial stages of formation. They may have provided the basic energy source for ionizing the intergalactic gas. (auth) (UK)

6310 SPIN UP IN NEUTRON STARS: THE FUTURE OF THE VELA PULSAR. Baym, Gordon; Pethick, Christopher; Pines, David (Univ. of Illinois, Urbana). Nature (London); 224: 872-4(29 Nov 1969).

Assuming that the speedup of the Vela pulsar was caused by a "starquake," a number of predications are made, and the event can be taken as evidence that the interior of the pulsar is a superfluid. (auth) (UK)

6311 SPECTRA OF EXTENDED EXTRA GALACTIC RADIO SOURCES. Bridle, A. H. (Queen's Univ., Kingston, Ont.). Nature (London); 224: 889-90(29 Nov 1969).

The extended extragalactic radio sources are considered to be late stages in the evolution of relativistic plasma and magnetic fields ejected from galactic nuclei or quasars. The processes by which these sources are formed are not understood, but it is considered that observations of their radio emission may provide useful constraints on theories of their development. With regard to the findings of Scheuer and Williams (Ann. Rev. Astron. Astrophys. 6: 321(1968)) that the component spectra of multiple sources are essentially similar, it is stated that the argument of these authors is misleading, and that it is premature to form such a conclusion from the present data. High-resolution maps of some extended sources at several frequencies have shown directly that this conclusion is incorrect, and in this connection a comparison is made between the MKN spectra of Macdonald et al. (Mon. Not. Roy. Astron. Soc. 138: 259(1968)) and the total spectra of these sources. For certain sources the spectral index decreases with decreasing frequency, and this may indicate that an absorption mechanism operates within one or more components of the source. The total spectrum is sensitive to such effects since they introduce large departures from power low spectra over small frequency ranges. It is concluded that significant differences are observable among component spectra of 40 to 50% of the extended extragalactic sources, contrary to the suggestion that these spectra are, in general, the same. (UK)

6312 SUPERNOVA OF AD 1437. Milne, D. K. (Commonwealth Scientific and Industrial Research Organization, Sydney). Nature (London); 224: 891(29 Nov 1969).

It has been suggested that the radio source CTB 35 is a supernova remnant, possibly associated with the Chinese supernova record of AD 1437. This was based on an incorrect interpretation of the radio data, leading to the deduction that the source had a nonthermal spectrum. It was subsequently shown from continuum and other observations that it is a thermal complex well identified with emission nebulae, and the suggestion that it is a supernova remnant is not justified. It is considered possible that the nonthermal double source CTB 37 is the remnant of the AD 1437 event. (UK)

6313 LINEAR POLARISATION OF PULSAR PSR 0833-45 AT 4.8 GHz. Gardner, F. F.; Whiteoak, J. B. (Commonwealth Scientific and Industrial Research Organization, Sydney). Nature (London): 224: 891-3(29 Nov 1969).

Observations of this pulsar at 6 cm indicated a double structure for the pulse, a drop in polarization from 100% to 50% near the pulse maximum, and a nonlinear variation of polarization angle across the pulse. Those observations are interpreted in terms of an oblique rotator model for the pulsar. The observations were made on May 19, 1969, with the Parkes 210-ft reflector, using a 6 cm parametric receiver. Integrated pulse shapes for sets of 400 pulses were obtained by use of a 400-channel pulse-height analyzer, and the mean intensity, percentage polarization and direction of polarization at intervals of 0.44 ms over the pulse were computer calculated by least-squares analysis. Results are shown graphically. Large variations in pulse shape and intensity appear to arise in the mechanism producing the radiation; the increase of variability with frequency rules out scintillation in the intervening medium. The mean energy spectrum indicates a radiation cutoff frequency near 5 GHz. (UK)

6314 ABSORPTION OF HIGH ENERGY GAMMA RAYS IN THE VICINITY OF PULSAR NP0532. McBreen, B. (Cornell Univ., Ithaca, N. Y.). Nature (London): 224: 893(29 Nov 1969).

It is suggested that photon–photon absorption may remove high-energy γ rays from the vicinity of pulsar NPO 532 in the Crab Nebula. In discussing this it is assumed that the volume occupied by the optical and x-ray photons is the same as or larger than that from which the pulsed γ rays may originate; also that the emission of the optical and x-ray pulses is isotropic and that their distribution in the source is also isotropic. Absorption between optical photons and high energy γ rays is first considered, following by consideration of absorption between keV x rays and γ rays of energy >50 MeV. If the optical and x-ray pulsed fluxes are joined by a straight line and the conditions discussed are correct, then pulsed γ rays of energy greater than about 50 MeV will be strongly absorbed in the source. A number of effects that introduce large uncertainties are mentioned. If beaming of the radiation occurs, however, the absorption cannot be estimated. (UK)

6315 CURRENT DEVELOPMENTS IN COSMIC X-RAY ASTRONOMY. Pounds, K. A. (Univ. of Leicester, Eng.). Proc. Roy. Soc. (London), Ser. A; 313: 367-80(11 Nov 1969).

A review is given of the current developments in the observation of 0.2 to 100 keV x rays originating outside the solar system. Discussion is limited to experiments which are under development and are likely to be flown within the next three years or so. Throughout this period experimental limits will continue to be set primarily by the available launch vehicles. Small rockets, and for energies above 20 keV, steerable balloons will continue to be the principal means of observation of cosmic x rays, though with increasing use of attitude controlled rockets. In 1970 or 1971 the first satellite payloads specifically designed for cosmic x-ray studies should be launched, bringing a notable advance in sensitivity and resolution of the observations. For illustration of the kind of data to be expected in the period under review, reference is made to a wide range of specific payloads. Performance figures quoted were estimated by the author, where not provided by the individual experimenter, and an attempt is made to achieve overall consistency in the criteria for judging experimental performance. The current observational aims of x-ray astronomy may be summarized as follows: (1) detection of new sources, obtaining approximate positions and intensities; (2) determination of accurate source positions to facilitate identification studies; measurement of the sizes of sources and, if extended, also their structure; measurement of the detailed spectrum over a wide energy band for both discrete sources and the diffuse background radiation; study of source variability; and measurement of polarization of the x radiation. 9 references. (auth) (UK)

6316 FUTURE REQUIREMENTS FOR COSMIC X-RAY ASTRONOMY. Boyd, R. L. F. (University Coll., London). Proc. Roy. Soc. (London), Ser. A; 313: 381-93(11 Nov 1969).

The main observational needs of x-ray astronomy are briefly reviewed and the existing techniques with their limitations are discussed. Some promising new developments are introduced and the properties of some important systems in terms of signal/noise ratio are considered. The relevance of on-board computers to this branch of space science is stressed, and a summary is given of the requirements for research and development in the near future. 7 references. (auth) (UK)

6317 OBSERVATIONS OF THE STRUCTURE OF RADIO SOURCES IN THE 3C CATALOGUE. II. Mackay, C. D. Mon. Notic. Roy. Astron. Soc.; 145: 31-65(1969).

The One-Mile radio telescope at Cambridge was used to map the structure of further 60 radio sources in the 3C catalogue at 408 and 1407 MHz. Contour maps in the sources are shown, together with a list giving the position, angular size, and flux density of each component; the optical fields of the same regions of sky are also briefly described. (auth) (UK)

Solar Phenomena

Refer also to abstracts 6391, 6397, and 6458.

6318 (ORNL-tr-2248) RADIATION EFFECTS ON EARTH SATELLITES AND SOLAR PROBES DURING SOLAR FLARES. Wohlleben, K. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Raumfahrtforschung; 13: 54-61(1969). 20p. Dep. CFSTI.

The radiation effects caused by solar flare protons are examined for earth satellites and solar probes. The calculations are based on the annual flux of solar protons near to the Earth's orbit (1 au) estimated from empirical relationships with the sunspot number for sunspot cycle 20 (1965–1975), account being taken of the propagation of solar protons in interplanetary space and the shielding effect of the Earth's magnetic field. For the planned solar probe (perihelion 0.3 au, aphelion 1.0 au) a cumulative radiation effect 2.8 times greater than in 1 au is anticipated. With an equatorial synchronous satellite and a shielding thickness <0.5 g/cm^2—as well as with the AZUR satellite—the cumulative radiation effects (defects/cm^{3}a, Rad/a, solar cell damage/a) are always smaller than the effects produced by Van Allen radiations (AZUR) or greater than the latter (synchronous satellite with shielding >0.5 g/cm^2). (auth)

6319 MAGNETIC FIELD FLUCTUATIONS NEAR THE MOON. Krall, Nicholas A.; Tidman, Derek A. (Univ. of Maryland, College Park). J. Geophys. Res.; 74: 6439-43(1 Dec 1969).

It is proposed that magnetic field fluctuations in the solar wind near the Moon are due to ballistic effects, i.e., they derive from electrons recently arrived from regions of plasma turbulence and are not connected with either wave or stability properties in the regions where the fluctuations are observed. (auth)

6320 DETECTION OF INTERPLANETARY MAGNETIC FIELD FLUCTUATIONS STIMULATED BY THE LUNAR WAKE. Ness, N. F.; Schatten, K. H. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 74: 6425-38(1 Dec 1969).

The analysis of detailed measurements at 5.11-second intervals by the NASA–GSFC magnetic field experiment on lunar Explorer 35 in the vicinity of the Moon has revealed the presence of rapid fluctuations up to the instrument bandpass of 5 Hz with amplitudes of several gammas. These disturbances are transmitted both up and downstream from the penumbra into regions of space directly connected to the penumbra by the magnetic field. Similar fluctuations are not observed in the center of the lunar wake, the solar-wind plasma umbra, where no plasma is present. Power spectral analyses made in a field-aligned coordinate system reveal that these fluctuations have approximately the same amplitude both parallel and transverse to the average field direction. Statistical studies are presented of the frequency of occurrence of the disturbances as a function of the distance to the point of observation from the lunar wake and of the fluctuation amplitude, and correlation with field magnitude. These observations suggest that the fluctuations have their source where the solar wind proton and electron distribution functions are disturbed by the removal of particles by absorption by the Moon. Instabilities induced by this disturbance of the electron distribution function are postulated as the source of the fluctuations, and their propagation with the electron velocity, which is greater than the bulk speed of the solar wind, allows the upstream solar wind to be affected by the wake of the Moon. (auth)

6321 EFFECTS OF SOLAR FLARE DURATION ON A DOUBLE SHOCK PAIR AT 1 AU. Hundhausen, A. J.; Gentry, R. A. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res.; 74: 6229-37(1 Dec 1969).

Numerical solutions of the time-dependent equations of motion for spherically symmetric flow are obtained to study the propagation and modification of the forward–reverse shock pair in the region between the Sun and 1 AU. For cases where the duration of the disturbance is long compared to T, the shock transit time to 1 AU, a double shock pair that resembles those predicted by similarity theory occurs at 1 AU. In cases where the duration of the solar disturbance is less than about 0.45 T, the shock pair structure is appreciably altered by a rarefaction, initiated at the end of the solar disturbance, which has caught up with the shock pair. In cases where the duration is less than about 0.1 T, the rarefaction completely destroys the reverse shock, leaving a single shock. This analysis indicates that a forward–reverse

shock pair will not be observed at 1 AU unless the time duration of the solar disturbance is greater than about 5 hours. Since solar flares that last this long are quite rare, it is concluded that observation of a flare-associated forward–reverse shock pair at 1 AU is unlikely. (auth)

6322 CORRELATION OF SOLAR MICROWAVE AND SOFT X-RAY RADIATION. 2. THE BURST COMPONENT. Wende, Charles D. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 74: 6471-81(1 Dec 1969).

A study of the histories of solar flares observed at 2 cm at the North Liberty Radio Observatory of the University of Iowa and observed at x-ray wavelengths with Mariner 5 (2 to 9 A) and Explorers 33 and 35 (2 to 12 A) shows that "post-burst increase" and "gradual rise and fall" events are concurrent microwave and soft x-ray phenomena. The correlation between the x-ray flux and the radio flux is high but nonlinear. The character of the correlation is consistent with a thermal flare theory in which the volume emissivity at x-ray wavelengths is of the spectral form $(dE/d\nu) \sim \exp(-h\nu/kT)$ and the radio flux is from the same region that is optically thick with a temperature T. The correlation yields the peak flare temperature, T_p, and the flare solid angle in terms of the fractional increase in temperature relative to the peak temperature, $F = \delta T/T_p$. Comparing flare sizes with those obtained by other means (e.g., x-ray telescopes) shows $F > 0.2$. If free–free emission is assumed responsible for both the x-ray and the radio emissions, an $F \sim 0.5$ is consistent with the initial assumptions, whereas an $F \sim 1.0$ is not. Thus, temperatures typically double during a flare. Of twenty cases studied, an $F = 0.5$ yielded a mean peak temperature of 4 million degrees Kelvin and a mean effective diameter of 32 arc seconds. (auth)

6323 GEOPHYSICAL MECHANISMS FOR ^{14}C VARIATIONS. Grey, Donald C. (Univ. of Utah, Salt Lake City). J. Geophys. Res.; 74: 6333-40(1 Dec 1969).

Simple models are employed to discuss the effects of the modulation of the cosmic-ray flux in the Earth's atmosphere by the solar wind and by geomagnetic field variations on the variations of ^{14}C in the atmosphere. It is shown that a good predictive model of short-term variations in atmospheric ^{14}C can be based on sunspot numbers, whereas long-term variations appear to correlate well with paleomagnetic variations. (auth)

6324 TEMPORAL VARIATIONS OF SOLAR LYMAN ALPHA. Meier, R. R. (Naval Research Lab., Washington, D. C.). J. Geophys. Res.; 74: 6487-90(1 Dec 1969).

Geocoronal Lyman α was observed by the OGO 4 spacecraft from August through December 1967. The emission rate at a fixed orientation with respect to the Sun was found to have short-term fluctuations of less than ±5% superimposed on a monthly (or 27-day) variation of as much as ±15%. These phenomena are attributed to variability of the Lyman-α flux at the center of the solar emission line. (auth)

6325 SOLAR MICROWAVE BURST FROM BEHIND-THE-LIMB PROTON FLARE. Badillo, V. L.; Salcedo, J. E. (Manila Observatory, Quezon City, Philippines). Nature (London); 224: 503-4(1 Nov 1969).

Reference is made to the solar microwave burst which occurred on March 30, 1969, which was unusual in two respects. Firstly, the values of the peak flux densities were the largest ever recorded in the cm range; secondly, the burst could be associated with a behind-the-limb proton flare. At the time of this solar radio burst an eruptive prominence was recorded from the west limb, and the tops of postflare loops were visible 45 min after commencement of the microwave burst. Data from Pioneer satellites indicated the arrival of solar protons about an hour after the radio event. At 18.5 hr after the radio event a sudden commencement of 22 gammas was recorded. The spectrum of the peak flux densities is shown, showing a decrease at 17 GHz. No minimum is shown in the dm range. The time development of the radio burst is also shown graphically; the progressive time delays of peak values in the direction of decreasing frequency suggest an outward motion of the radio emission source. There was only one important peak at each frequency. The progressive time delays of the starting times, also in the direction of decreasing frequency, are also shown. Riometer records showed no absorption, but rather a slight increase in radio noise. These were indications of x rays, capable of ionizing the D region, associated with the proton flare. The significance of the results with regard to theories of proton flares, the propagation of protons and cm waves from beyond the limb are emphasized. (UK)

6326 INTERPRETATION OF SOLAR HELIUM-LIKE ION LINE INTENSITIES. Gabriel, A. H.; Jordan, Carole. Mon. Notic. Roy. Astron. Soc.; 145: 241-8(1969).

Recent identification of the $2^3S \rightarrow 1^1S$ line from helium-like ions in the solar soft x-ray spectrum, followed by calculation of its transition probability, enables an analysis of the observations to be carried out, based on intensities of the three lines $2^1P \rightarrow 1^1S$, $2^3P \rightarrow 1^1S$, and $2^3S \rightarrow 1^1S$. The relative collision rates to the excited levels and the electron densities in the emitting regions were determined, subject to the limitation of available observations. Densities of $\simeq 3 \times 10^9$ cm^{-3} are found from lines formed over the quiet corona, but values between 10^9 and 10^{11} cm^{-3} are found from lines emitted in active regions, and the highest electron densities occur in the hottest regions. (auth) (UK)

6327 MAGNETIC FIELD OBSERVATIONS FOR THE SUNSPOT C.M.P. 1966 SEPTEMBER 19. Adam, M. G. Mon. Notic. Roy. Astron. Soc.; 145: 1-20(1969).

Magnetic vector directions were measured at 119 points over the field of a large, long-lived sunspot on September 19, 1966, when the spot was closely at central meridian passage. Further developments in Treanor's (1960) method of determining field directions enable the directions to be obtained independently for the violet and red sigma components in the Zeeman patterns of the absorption lines. Reliability of the determinations is indicated by agreement between these two results, and for such agreeing determinations the field configuration shows a simple axially symmetric arrangement, which is also supported by the field strength measurements. A discussion of the accuracy obtainable in field direction measurements, by Treanor's and by other methods, shows the greater potentiality of Treanor's procedure. The discussion leads also to the conclusion that apparent anomalies in the present results, at least in the sunspot umbra, lie within the uncertainty of the observations. For some of the penumbral regions, however, the apparent inconsistencies in the deduced magnetic field directions may indicate a genuine solar effect. (auth) (UK)

6328 VARIATIONS OF THE FORM OF TROPOSPHERIC CIRCULATION RELATED TO THE MACROSTRUCTURE OF THE SOLAR WIND. Smirnov, R. V. (Inst. for Marine Hydrophysics, Katsiveli, Crimea). Dokl. Akad. Nauk SSSR; 187: 1278-81 (21 Aug 1969). (In Russian).

The tropospheric circulation and changes in its form are due to the simultaneous effects of thermal machines, rotation of the Earth, cyclones and solar activity. The density distribution of the energy flux in various sectors of the interplanetary field may be estimated on the basis of velocity distribution of the solar wind. On the basis of weekly synoptic charts of the Atlantic–Eurasian sector, the elementary synoptic processes were identified, determining the form of circulation by Wangenheim's classification. The pressure of the solar plasma on the terrestrial magnetosphere is affected to the largest extent when the Earth passes through the initial portion of the quasi-stationary current; during this period the velocity of the plasma increases sharply without a decrease of its density. Days with the largest daily increase of the solar wind velocity were used for reference. A composite baric map was developed on the basis of the chosen geopotential data. (TTT)

Galaxies

6329 THE SPIRAL STRUCTURE OF OUR GALAXY. I. Bok, Bart J. (Univ. of Arizona, Tucson). Sky Telesc.; 38: 392-5(Dec 1969).

A report is presented on the conference held at Basel, Switzerland (Aug–Sept, 1969) on the spiral structure of the Milky Way. Topics summarized include historical synopsis, spiral arm definition, spiral galaxies of the local group and beyond, gravitational theory, and influence of magnetic fields. (W.D.M.)

6330 ORIGIN OF ARMS IN SPIRAL GALAXIES. Arp, Halton (Mount Wilson Observatory, Pasadena, Calif. Palomar Observatory, Pasadena, Calif.). Sky Telesc.; 38: 385-7(Dec 1969).

It is suggested that the origin of the spiral arms in galaxies is the ejection of luminous material from the nuclei. As soon as differential rotation affects any jet or linear marking in the disk of a galaxy, it is naturally drawn out into a spiral form, and the tendency for opposite ejections furnishes a natural explanation for the predominance of symmetric two-arm spirals. (W.D.M.)

6331 OBSERVATIONS AT 178 MHz OF THE NORTH GALACTIC SPUR. Holden, D. J. Mon. Notic. Roy. Astron. Soc.; 145: 67-73(1969).

The structural features of the North Galactic Spur at 178 MHz are described and compared with those noted by other observers. (auth) (UK)

6332 PULSAR DISTANCES, SPIRAL STRUCTURE, AND THE INTERSTELLAR MEDIUM. Mills, B. Y. (Univ. of Sydney). Nature (London); 224: 504-5(1 Nov 1969).

An approach to estimating pulsar distances is discussed which involves making a crude first order approximation that the pulsars are immersed in a uniform dispersing medium, then calculating

the distances and directions of all pulsars on this assumption, and comparing the results with the properties of other galactic components, particularly supernova remnants, which would appear to have a common origin. Discrepancies revealed in this comparison may then be used to refine the assumed model of the interstellar medium and improve the distance scale. The distribution of the 40 pulsars of known dispersion measure is shown plotted as projected onto the galactic plane, on the assumption that their distances are directly proportional to their dispersion measure. If the pulsars and the dispersing medium are uniformly distributed throughout the galactic disk the plot would be expected to show circular symmetry, which it does not; features are displayed which appear to be closely related to the H I spiral pattern, and the groupings reproduce quite well in direction and distance the local and Sagittarius spiral arms. The high dispersion pulsars marking extensions of these arms appear particularly significant. It is concluded that the crude first-order approximation to the free electron distribution may be more accurate than reasonably expected. In the light of these suggestions some of the relevant observed properties of the interstellar medium are considered. (UK)

Cosmology

Refer also to abstracts 6760 and 6761.

6333 VELOCITY OF GRAVITATIONAL WAVES. Salisbury, W. W. (Smithsonion Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Nature (London); 224: 782-3(22 Nov 1969).

There is observational evidence that waves may exist in the gravitational field in space (Weber, Phys. Rev. Lett. 22: 1320 (1969)). Wave motion in general requires energy transfer between two modes of energy storage, and the existence of gravitational waves in space thus requires a further system of energy storage coupled with that in the regular gravitational field. The field system for gravitational waves may be analogous to the system of magnetic and electric fields that accounts for electromagnetic waves, and in the gravitational case the analogue of the magnetic field is a spin–spin coupling force between rotating masses. This force, however, would be expected to be very small in any experimental arrangement now possible on Earth, but developments in the magnetic suspension of rotating masses in a vacuum made it possible to measure this small force. Measurement of the spin–spin coupling of two rotating masses will give an experimental value to the velocity of gravitational waves. It would also provide a crucial test of the theory of general relativity, and any result other than the velocity of light would require considerable reassessment of the theory. An outline is given of the laboratory apparatus required for such a measurement. (UK)

6334 AN ANGULAR DIAMETER–REDSHIFT TEST OF COSMOLOGICAL MODELS USING OBSERVATIONS OF WEAK RADIO SOURCES. Longair, M. S.; Pooley, G. G. Mon. Notic. Roy. Astron. Soc.; 145: 121-9(1969).

Recent observations with the Cambridge One-mile radio telescope provide angular-diameter data for sources having a wide range of flux densities. These enable cosmological models to be tested by comparing the number of sources of large angular diameter at different flux densities. On the basis of different world models, and the known distribution of the physical sizes of 3C sources, the expected numbers of extended sources in the 5C surveys are calculated. Significantly more sources of large diameter are found to be present in the 5C samples than are predicted by simple models; this excess may be explained by incorporating cosmological evolution. It is concluded that evolutionary changes are associated with the population of large diameter radio sources, which generally have radio luminosities in the range $10^{24} < P_{178} < 10^{26}$ W Hz^{-1} sr^{-1}, but that the changes are much less than those required for more powerful sources ($P_{178} > 10^{26}$ W Hz^{-1} sr^{-1}) in order to satisfy the total source counts. (auth) (UK)

6335 ANTIMATTER, GALACTIC NUCLEI, AND THEORIES OF THE UNIVERSE. Nature (London); 224: 477-81(1 Nov 1969).

The following two communications are presented under the above heading: (1) Speculation on the nature of the nuclei of galaxies–F. Hoyle (Cambridge Univ., Eng.) (2) Antimatter and cosmology–G. Steigman (Cambridge Univ., Eng.) In (1) a theory of particle–antiparticle creation in galactic nuclei is outlined. In (2) the following topics are discussed: antimatter; annihilation products; steady-state cosmology; Alfven–Klein cosmology; "big-bang" cosmology; and the unsymmetric Universe. (UK)

6336 IMPLICATIONS OF THE FAR-INFRARED BACKGROUND MEASUREMENTS. Wagoner, R. V. (Cornell Univ., Ithaca, N. Y.). Nature (London); 224: 481-4(1 Nov 1969).

The possibility of the far-infrared background radiation observed with a liquid-helium-cooled telescope carried to an altitude of 170 km by an Aerobee rocket being due to one or more narrow features produced outside the solar system is examined. If this radiation is of extragalactic origin most of it must come from sources of very similar redshift, and this can be achieved in cosmological models of the Lemaître type, but difficulties arise in connection with relationships between the deceleration parameters and the redshift magnitudes, and for other reasons. Strong emission during the protogalactic cooling process is another possible extragalactic source, but this phase must occupy the same short interval of cosmic time for most galaxies to prevent the lines becoming too broad. These two models illustrate the difficulties encountered if the observed flux is considered to originate at cosmological distances. The present author considers the other most likely source—our own Galaxy. Since there is no reason to believe that our Galaxy is not typical of an average spiral, the flux produced by all the galaxies in the Universe due to such emission is computed. Only the case where most of the emission occurs from a single line is considered, since the results for many lines can then be easily obtained by superposition. (UK)

6337 SEARCH FOR GHOST IMAGES: A STATISTICAL TEST. Petrosian, V.; Ekers, R. D. (California Inst. of Tech., Pasadena). Nature (London); 224: 484-8(1 Nov 1969).

In an expanding closed Universe photons from a source can reach an observer from diametrically opposite directions if the antipode of the observer is within his horizon. This is possible in Lemaître-type universes with nonzero cosmological constant, and has been used as a test for such a cosmology (Solheim, Nature 217: 41(1968)). Solheim claimed that the number of faint 4C sources diametrically opposite each other is greater than expected from a random distribution of sources, and that the probability of finding a radio source diametrically opposite a quasar is larger than average for certain redshift ranges. The present authors, using an independent set of data, could not substantiate these results, and they consider that Solheim's results are statistically insignificant. It is shown, however, that this is in no way an argument against such cosmological models since, although the possibility exists of observing diametrically opposite images belonging to a single source, the fraction of sources for which this could happen is very small. This state of affairs is mainly an outcome of the very short lifetime of these sources compared with the age of the Universe, so that only sources very close to the antipode can be seen with two images in opposite directions in the sky. Some tests applied to the Parkes Catalogue of Radio Sources are discussed, and the results used to place limits on cosmological models. Calculations are made, for Lemaître-type models, of the fraction of radio sources with two images which will be included in a survey to a given flux limit, having first obtained expressions for the luminosity function and the age of the sources. It is concluded either that the Universe is not Lemaître-type, or if Lemaître-type, then either the inhomogeneities, such as galaxies, were formed at an early epoch, or sources near the antipode have random velocities in excess of 6,000 km/sec. (UK)

6338 COLLAPSING OBJECTS AND THE BACKWARD EMISSION OF LIGHT. Jaffe, Jack (Goddard Space Flight Center, New York). Ann. Phys. (N.Y.); 55: 374-90(Nov 1969).

A general and comprehensive analysis is presented of the characteristics of light emitted from a collapsing, nonrotating gas within the framework of general relativity. The results are contrasted with the analogous special relativistic situation. It is found that there exist restrictions on the range and frequency shift of escaping light that are purely general relativistic. One particularly interesting result is that, unlike the special relativistic analog, light emitted from an optically thick collapsing gas will never be received blue-shifted by an observer. (auth)

6339 POWER SPECTRUM ANALYSIS OF THE EMISSION-LINE REDSHIFT DISTRIBUTION OF QUASI-STELLAR AND RELATED OBJECTS. Plagemann, S. H.; Feldman, P. A.; Gribbin, J. R. (Cambridge Univ., Eng.). Nature (London); 224: 875-6 (29 Nov 1969).

An analysis of a recent list of 186 redshifts indicates that, at best, only marginal importance can be attached to the periodicities in the redshift distribution that were found by others. (auth) (UK)

Planetary Phenomena

6340 MODIFICATION OF THE MARTIAN IONOSPHERE BY THE SOLAR WIND. Cloutier, P. A. (Rice Univ., Houston, Tex.); McElroy, M. B.; Michel, F. C. J. Geophys. Res.; 74: 6215-28 (1 Dec 1969).

A dynamical model is developed for interaction of solar wind

with Martian ionosphere. It is assumed that Mars has a negligible magnetic moment, and a radiative equilibrium model, characterized by an exospheric temperature of 490°K, is adopted for the neutral atmosphere. The ionospheric structure is determined by integration of Maxwell's equations for a 3-component fluid, in combination with the equations for conservation of mass, momentum, and energy. It is demonstrated that a standing bow shock wave is required by the interaction of solar wind with the ionosphere. Profiles of various flow parameters, as well as electric and magnetic field profiles, are calculated, and the problem of how to extrapolate present results, which are strictly applicable only at the subsolar point, to other locations on the planet is discussed. The computed ionospheric structure is compared with the ionospheric profile observed by Mariner 4 and is found to agree satisfactorily. In particular, the dynamic model predicts a constant scale height of 29 km over an extensive altitude regime, in excellent agreement with the observed value. The dynamic scale height is smaller by a factor of 2 than the value computed under assumptions of photochemical equilibrium, a consequence of the pressure exerted on the ionosphere by the solar wind plasma. (auth)

6341 CALCULATED SPACE RADIATION ENVIRONMENTS FOR THE GRAND TOUR MISSIONS. Haffner, J. W. (North American Rockwell Corp., Downey, Calif.). Trans. Amer. Nucl. Soc., 12: 421-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 6644 and 6777.

6342 (PP-2/80) RULE OF REVERSIBILITY ON BACK-SCATTERING OF PROTONS ON COPPER MONOCRYSTALS. Scherzer, B. M. U. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1969. 34p. (In German). Dep. CFSTI (U. S. Sales Only).

The applicability of the rule of reversibility to anisotropic Rutherford backscattering of 60- and 120-keV protons from Cu monocrystals was investigated at various temperatures. This was done by measuring the angular and energy distributions of the backscattered hydrogen atoms, both for incidence and observation at small angles to the ⟨110⟩ direction. Contour line plots of the backscattering minima were made for the various depths of backscattering. The closer to the surface the backscattering is and the higher the primary energy and the lower the temperature, the better is the agreement between the channeling and blocking minima. Deviations for backscattering from large depths can be ascribed to energy losses of the protons in the lattice. The half-widths for the channeling and blocking effects can be determined from the backscattering minima. At all temperatures the half-width for the blocking effect is a factor of $\sqrt{2}$ larger than that for the channeling effect. They are both smaller than the Lindhard angle and depend on the energy as $1/\sqrt{E}$. The backscattering minima are noticeably affected by radiation damage. (auth)

6343 (RD/B/N-1484) STRAGGLING-ENERGY CURVES FOR keV IONS IN SOLIDS DERIVED FROM THE THEORETICAL ANALYSIS OF LINDHARD, SCHARFF, AND SCHIOETT (1963). Channing, D. A.; Turnbull, J. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Aug 1969. 13p. Dep. CFSTI (U. S. Sales Only).

Individual straggling-energy curves for a wide variety of ions and targets at energies 1 to 500 keV are presented. They are derived from the theoretical analysis of Lindhard, Scharff and Schioett (1963), and apply to amorphous media or to crystalline material when channeling is minimal. (auth) (UK)

6344 SECONDARY-ELECTRON SPECTRA AND CHARACTERISTIC ENERGY LOSSES OF SILICON SINGLE CRYSTALS. Shul'man, A. R.; Morozov, Yu. A.; Korablev, V. V. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 11: 1101-3(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1360-3(May 1969).

The electrical differentiation method and synchronous detection are employed in order to experimentally study the spectra of slow true secondary electrons and electrons reflected with characteristic energy losses. It is shown that, as the incident-electron energy E_p increases, the peak width of the true secondary electrons decreases (from 9 eV for E_p = 100 eV to 4 eV for 1000 eV). The form of the electron spectrum changes with the characteristic energy losses: an increase in E_p leads to a decrease in the peak intensity associated with surface plasmons whereas the intensity of peaks corresponding to bulk plasmons increases. (auth)

6345 DESIGN AND ANALYSIS OF A HIGH INTENSITY FAST OXYGEN ATOM SOURCE. Miller, David R.; Patch, Dan F. (Univ. of California, San Diego, La Jolla). Contract DA-31-124-ARO-D-257. Rev. Sci. Instrum.; 40: 1566-9(Dec 1969).

A mixture of 5% O_2 in He has been used in a rf discharge at pressures from 15 to 70 torr to produce a free jet source of a high-intensity energetic beam of atomic oxygen. Intensities of 10^{17} atoms/sec/sterad are predicted and energies of 0.33 eV have been measured. A time-of-flight analysis of the beam properties is presented and indicates that the source temperature is near 620 K. (auth)

6346 TEMPERATURE DEPENDENCE OF THE DIFFUSE SCATTERING OF FAST ELECTRONS IN POLYCRYSTALLINE SILVER FOILS. Zechnall, W. (Univ., Hamburg). Z. Phys., 229: 62-80(1969). (In German).

The filtered and unfiltered intensities of electrons (30 to 50 keV) scattered in thin polycrystalline silver foils (300 to 1400 Å) were measured by means of a retarding field apparatus from 170 to 380°K. The absorption coefficients due to the inelastic and elastic scattering processes were determined. The diffuse elastic scattering intensity increases with temperature for all values of thickness and electron energy. From the measured absorption coefficients, the contributions of the different elastic scattering processes to the total background intensity are calculated. The main contribution is due to multiple scattering processes including both Bragg reflections and thermal diffuse scattering. In contrast with the filtered diagram, the background intensity of the unfiltered diagram increases with temperature only for larger scattering angles. In the small-angle region, a reversed temperature behavior is observed. This effect is caused by that part of the inelastically scattered electrons at low angles coming directly from the primary beam and from the low-order diffraction rings. (auth)

6347 STOPPING POWER OF Zr, Gd, AND Ta FOR 5- TO 12-MeV PROTONS AND DEUTERONS. FURTHER EVIDENCE OF AN OSCILLATORY BEHAVIOR OF THE EXCITATION POTENTIAL. Andersen, H. H.; Simonsen, H.; Soerensen, H.; Vajda, P. (Danish AEC Research Establishment, Risoe). Phys. Rev.; 186: 372-5(10 Oct 1969).

The stopping power of Zr, Gd, and Ta for 5- to 12-MeV protons and deuterons was measured. The accuracy was 0.3% for Zr and Ta and 0.6% for Gd. The results are compared with Risö data published earlier, and it is shown that the ratio between the mean excitation potential and the atomic number cannot be a monotonically decreasing function of the atomic number. An oscillatory dependence is suggested. (auth)

Atomic and Molecular Properties

6348 (NSRDS-NBS-22(Vol.2)) ATOMIC TRANSITION PROBABILITIES. VOLUME II. SODIUM THROUGH CALCIUM. A Critical Data Compilation. Wiese, W. L.; Smith, M. W.; Miles, B. M. (National Bureau of Standards, Washington, D. C.). Oct 1969. 304p. GPO $4.50.

Atomic transition probabilities for about 5,000 spectral lines of the second ten elements, based on all available literature sources, are critically compiled. The data are presented in separate tables for each element and stage of ionization. For each ion the transitions are arranged according to multiplets, supermultiplets, transition arrays, and increasing quantum numbers. Allowed and forbidden transitions are listed separately. For each line the transition probability for spontaneous emission, the absorption oscillator strength, and the line strength are given along with the spectroscopic designation, the wavelength, the statistical weights, and the energy levels of the upper and lower states. In addition, the estimated accuracy and the source are indicated. In short introductions, which precede the tables for each ion, the main justifications for the choice of the adopted data and for the accuracy rating are discussed. A general introduction contains a detailed discussion of the critical factors entering into each major experimental and theoretical method. It also includes a general critical assessment of the widely used Coulomb approximation, and a number of illustrative examples for the exploitation of regularities or systematic trends among oscillator strengths. (auth)

6349 THE ENERGY SIGNIFICANCE OF RACAH'S QUANTUM NUMBERS IN Dy^{2+}. Synek, M.; Ramirez, R. (Texas Christian Univ., Fort Worth). Phys. Lett.; 30A: 332-3(17 Nov 1969).

Analytical self-consistent-field results for a number of states of Dy^{2+} (Z = 66), $4f^{10}$, are used to demonstrate the specific extent of the generally known energy significance of the Racah's quantum numbers ν and $U \equiv (u_1, u_2)$. (auth)

6350 MATRIX ELEMENTS FOR BOUND–FREE TRANSITIONS IN ATOMIC HYDROGEN. Holt, A. R. (Univ. of Essex, Colchester, Eng.). J. Phys., B (London): 2: 1209-13 (Nov 1969).

Alternative methods of calculating bound–free matrix elements for atomic hydrogen are presented. Expressions previously given for ionization from 2s and 2p states are shown to be incorrect, and new expressions are derived. (auth) (UK)

6351 RADIATIVE DECAY OF METASTABLE HYDROGENIC ATOMS. Klarsfeld, S. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett.; 30A: 382-3(1 Dec 1969).

A new highly accurate theoretical estimate of the two-photon decay rate of metastable hydrogenic atoms, viz., $1/\tau = (8.2283 \pm 0.0001)\ Z^8\ sec^{-1}$, is obtained by performing exactly the summation over intermediate states. (auth)

6352 METHOD FOR MEASURING THE ANOMALOUS MAGNETIC MOMENT OF FREE ELECTRONS. Graeff, G.; Klempt, E.; Werth, G. (Univ., Bonn). Z. Phys., 222: 201-7(1969).

It is shown that a previously described method for measuring the spin resonance of free electrons in a trap can also be used to measure their (g – 2) anomaly. The electrons are trapped in an electrostatic quadrupole field with a superimposed homogeneous axial magnetic field and are polarized by spin exchange. The spin and (g – 2) resonance are monitored through the spin dependence of the excitation process e + Na(3 S) → e + Na(3P). Calculations are made of the energy levels and transition probabilities of the trapped electrons. (auth)

6353 MEASUREMENTS OF THE HYDROGEN–DEUTERIUM ATOMIC MAGNETIC MOMENT RATIO AND OF THE DEUTERIUM HYPERFINE FREQUENCY. Larson, D. J.; Valberg, P. A.; Ramsey, N. F. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 23: 1369-72(15 Dec 1969).

The ratio of the hydrogen atomic magnetic moment to that of deuterium has been measured by spin-exchange detection of Zeeman ($\Delta F = 0$, $\Delta m_F = -1$) transitions in an atomic hydrogen maser. The value of this ratio is found to be 1.000 000 009 4(14) in agreement with a recent theoretical calculation. The spin-exchange technique has also been used to measure the zero-field ground-state deuterium hyperfine frequency. The result is $\Delta\nu(D)$ = 327 384 352.51(5) Hz. (auth)

6354 REMEASUREMENT OF ΔE–S IN ATOMIC HYDROGEN. Cosens, B. L.; Vorburger, T. V. (Yale Univ., New Haven). Phys. Rev. Lett.; 23: 1273-5(1 Dec 1969).

The $2^2S_{\frac{1}{2}} - 2^2P_{\frac{1}{2}}$ separation ΔE–S in hydrogen was measured by a microwave atomic-beam technique. The result obtained from four independent transitions is ΔE–S = 9911.173 ± 0.042 MHz. This result is combined with the recent determination of the Lamb shift S by Robiscoe to obtain a value for the fine-structure splitting ΔE and a value for the fine-structure constant $\alpha^{-1} = 137.0358(5)$. (auth)

6355 APPLICATION OF EXCHANGE PERTURBATION THEORIES TO THE DELTA-FUNCTION MODEL OF H_2^+. Certain, P. R.; Hirschfelder, J. O.; Epstein, S. T. (Univ. of Wisconsin, Madison). Chem. Phys. Lett.; 4: 401-404(1 Dec 1969).

Four different types of exchange perturbation theories are solved to infinite order in the perturbation for the delta-function model of the hydrogen molecule ion. It is shown that the Eisenschitz–London or Hirschfelder second-order energy approaches one-half of the second-order polarization energy for this model at large internuclear separations. (auth)

6356 MOLECULAR BEAM STUDIES OF HeH AND H_3 MOLECULES. Gray, J.; Tomlinson, R. H. (McMaster Univ., Hamilton, Ont.). Chem. Phys. Lett.; 4: 251-4(15 Nov 1969).

Helium hydride and helium deuteride molecules were produced by neutralization of HeH^+ and HeD^+ in a molecular-beam apparatus. Minimum lifetimes of 10^{-8} sec are estimated for these molecules. Similar experiments have failed to produce evidence for D_2H or D_3 molecules having lifetimes of this order. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 6684.

6357 LIFETIME OF POSITRONS IN AN ELECTRON GAS. Garg, J. G.; Saraf, B. L. (Univ. of Rajasthan, Jaipur, India). Phys. Lett.; 30A: 369-70(17 Nov 1969).

The positron lifetimes in an electron gas are calculated using the bound-state concept of Bergersen. In order to explain the results of two-γ angular distribution, a fast exchange between the electron in the bound state and the free electrons outside it is assumed. The calculated annihilation rates are found to be in good agreement with the experimental and theoretical results. (auth)

Collision Phenomena

Refer also to abstracts 5965, 6415, and 6767.

6358 (COO–1528-39) TOTAL CROSS SECTIONS IN MOLECULAR CHARGE TRANSFER REACTIONS WITH DIATOMIC NEUTRALS. Smith, David (Kansas Univ., Lawrence. Utah Univ., Salt Lake City); Kevan, Larry (Kansas Univ., Lawrence. Wayne State Univ., Detroit, Mich.). Oct 1969. 9p. (CONF-690926–1). Dep. CFSTI.

From Conference on Mass Spectrometry, Kyoto, Japan.

Total charge-transfer cross sections are reported for oxygen and carbon monoxide with various projectile ions, including $C_2H_2^+$, O_2^+, Xe^+, CO^+, CO_2^+, Kr^+, N_2^+, Ar^+, Ne^+, and He^+. The total cross sections, which include the sum of all fragment ions produced, are plotted against the recombination energy of the various projectile ions. Average energy of the projectile ions was about 50 eV. It is concluded that the cross sections show resonance effects between the recombination energy of the primary ion and the lower vibrational state of the electronic state of the secondary ion. (A.G.W.)

6359 (ORO–2591-42) SCATTERING OF He^+ IONS BY NOBLE GASES AT HIGH ENERGIES. Taylor, G. O. Jr.; Martin, D. W.; Thomas, E. W. (Georgia Inst. of Tech., Atlanta. School of Physics). 3 Sep 1969. Contract AT(40-1)-2591. 164p. Dep. CFSTI.

The scattering of He^+ projectiles by impact on He, Ne, and Ar was investigated in the energy range 120 to 830 keV under single-collision conditions. Specifically, the experiment measured as a function of angle in the range one to eight degrees the total differential scattering cross section as well as the differential scattering cross sections for scattering without change of charge, for scattering with charge transfer, and for scattering with electron stripping. Also, the fraction of particles in a particular charge state was measured as a function of energy at fixed scattering angle. A Van de Graaff accelerator furnished a monoenergetic beam of ions from 120 to 1000 keV. Two circular holes of diameter 0.025 inch collimated the beam entering the collision region, where the target gas pressure was typically one micron. Particles scattered through an angle θ were collimated by a two-slit geometry, whose angular resolution was approximately 10 minutes of arc, passed through a parallel-plate electrostatic deflector for charge sorting, and counted individually with a silicon surface-barrier detector. The primary projectile beam in the collision chamber was monitored continuously by detecting the collisionally induced photon emission from the target with a photomultiplier. The sum of the differential cross sections for scattering He^0, He^+, and He^{2+} through an angle θ was equal to the measured total differential cross section. The absolute error associated with the total differential cross section is ±23 percent, the random error is estimated to be ±10 percent. This total differential cross section was found to equal the theoretical differential scattering cross section based on a classical calculation using a screened Coulomb-type potential. Thus, the scattering of the particles in these close encounters is determined by the mutual nuclear repulsion and may be adequately described by classical mechanics. The four differential scattering curves were parallel over the angular range investigated, indicating that P_n, the fraction of particles in a particular charge state n, was independent of the scattering angle. This result is consistent with theory and with experiments performed at slightly lower energies. There was excellent agreement for the energy dependence of P_n in all three target gases with data at lower energies. The random error in P_n is estimated to be ±10 percent. For the resonant case $He^+ + He$, it was found that P_0, the fraction of scattered particles that had picked up an electron during the collision, could be fitted in the investigated energy range by a semiempirical equation if a damping factor in the equation was properly adjusted. Also, good agreement was found when comparing P_n with the predictions of a statistical theory. (auth)

6360 (ORO–2591-43) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Progress Report No. 22, December 1, 1968–November 30, 1969. Martin, D. W.; Taylor, G. O.; Troyer, D. E. (Georgia Inst. of Tech., Atlanta. School of Physics). 30 Nov 1969. Contract AT(40-1)-2591. 11p. Dep. CFSTI.

A differential scattering apparatus designed for detailed cross-section measurements of fundamental ionization and charge-transfer processes involving incident hydrogen and helium ions in the energy range from 0.15 to 1 MeV is described. Noncoincidence

measurements of the scattering of He^+ ions by Ar, Ne, and He are discussed briefly (detailed results are presented in ORO-2591-41). Progress on construction of a slow recoil-ion analyzer is reported. (A.G.W.)

6361 (ORO-2591-44) EMISSION AND EXCITATION CROSS SECTIONS. Progress Report No. 5, December 1, 1968–November 30, 1969. Thomas, E. W.; Edwards, J. L.; Ford, J. C. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). 30 Nov 1969. Contract AT(40-1)-2591. 37p. Dep. CFSTI.

A study was made of the charge transfer processes whereby fast neutral atoms are formed in the 3s, 3p, and 3d excited states as a result of impact of protons on targets of helium, hydrogen, argon, and nitrogen. The technique involves quantitative measurement of Balmer alpha radiation emitted in the spontaneous decay of the excited atom. A time-of-flight technique allows separation of the 3s, 3p, and 3d state contributions to the emission. It is necessary to assess the influence of processes whereby the excited atoms are collisionally destroyed before they undergo spontaneous radiative decay. Detailed measurements of the collisional formation and destruction processes are presented for targets of He and N_2 and impact energies in the range 75 to 400 keV. Preliminary data for the case of H_2 and Ar targets are also shown. Comparison is made with theoretical predictions. The influence of stray electric fields on the validity of the measurements is discussed. (auth)

6362 INFLUENCE OF EXCHANGE AND POLARIZATION ON THE ELASTIC SCATTERING OF SLOW ELECTRONS FROM RARE GASES AND MERCURY. Weiss, H. F. (Univ., Munich). Z. Phys.; 229: 299-308(1969).

The elastic scattering of slow electrons from Ar, Kr, and Hg is calculated by means of phase shift analysis. In addition to the Hartree potentials, radial symmetric potentials are used simulating electron exchange and polarization of the shell electrons. It is found that spin polarization and differential cross sections are in relatively good agreement with the experimental results. (auth)

6363 IONIZATION OF COMPLEX ATOMS BY ION IMPACT. Salin, A. (Observatoire de Paris, Meudon, France). J. Phys., B (London); 2: 1255-6(Nov 1969).

The theory recently derived by Salin (1969) for the ionization by ion impact of atomic hydrogen is generalized to the ionization of complex atoms. (auth) (UK)

6364 ELASTIC SCATTERING OF ELECTRONS BY HYDROGEN. Oberoi, R. S.; Callaway, J. (Louisiana State Univ., Baton Rouge). Phys. Lett.; 30A: 419-20(1 Dec 1969).

A modification of the polarized orbital method is shown to give excellent low-energy s-wave phase shifts for electron–hydrogen elastic scattering. (auth)

6365 THRESHOLD EXCITATION OF H_2 AND D_2 BY ELECTRON IMPACT. Hall, R. I.; Mazeau, J.; Reinhardt, J. (Faculte des Sciences, Paris). Phys. Lett.; 30A: 427-8(1 Dec 1969).

An improved "retarding potential difference" technique and a precise energy calibration are used to identify the structure in the threshold excitation spectra of H_2 and D_2 between 11.7 and 14 eV with certitude as belonging to the vibrational series of the $c^3\Pi_u$ state. (auth)

6366 LARGE-ANGLE SCATTERING FROM N_2 WITH 40-keV ELECTRONS. Fink, M.; Bonham, R. A.; Lee, J. S.; Ng, E. W. (Indiana Univ., Bloomington). Contract AF49(638)1681. Chem. Phys. Lett.; 4: 347-8(1 Dec 1969).

Large-angle scattering data over the range $15 \leq s \leq 60 Å^{-1}$ [$s = (4\pi/\lambda)\sin\frac{1}{2}\theta$] for 40-keV electrons scattered by N_2 were obtained. Comparison of the data with the simple Born and Bethe theories shows that binding effects vanish by $s = 25 Å^{-1}$ and that these simple theories adequately represent the data to within 0.5% on an s^4I (s) scale between $25 \leq s \leq 40 Å^{-1}$. In the region $40 \leq s \leq 60$ the data deviate from these theories but can be brought into excellent agreement by the use of a reasonable energy response function for the detector. (auth)

6367 THE DETERMINATION OF CHEMICAL BINDING EFFECTS IN N_2 BY ELECTRON SCATTERING. Bonham, R. A. (Indiana Univ., Bloomington); Fink, M.; Kohl, D. A. Contract AF49(638)-1681. Chem. Phys. Lett.; 4: 349-51(1 Dec 1969).

The total differential (elastic plus inelastic) cross section was measured for electron scattering by N_2 with 40-keV electrons. Data were obtained over the range $1.5 \leq s \leq 12 Å^{-1}$ [$s = (4\pi/\lambda)\sin\frac{1}{2}\theta$]. The results are in excellent agreement with previous photographic measurements and conclusively show that previously observed maxima and minima in the intensity difference curve between experiment and independent-atom-model theory are the result of chemical binding. The binding energy was also estimated and was found to be too large by some 10 eV. (auth)

6368 ASYMPTOTIC SOLUTION OF COUPLED EQUATIONS FOR ELECTRON SCATTERING. Norcross, David W. (University Coll., London). Comput. Phys. Commun., 1: 88-96 (Oct, 1969).

The program ASYM solves coupled second-order differential equations of the type encountered in the close-coupling formulation of electron–atom (ion) scattering problems, at some specified point in the asymptotic region. Linearly independent sets of wave functions are found, which could be used as boundary solutions for a complete solution of the close-coupling integrodifferential equations. Solutions can be obtained for equations representing scattering near thresholds or from highly ionized atoms. The program will cope with any number of reaction channels up through six, and long-range potentials up through r^{-3}. The program is written in FORTRAN IV for IBM 360/65. (A.G.W.)

6369 MEASUREMENT OF LARGE ANGLE ATOMIC SCATTERING USING AXIALLY SYMMETRIC MAGNETIC FIELDS. Bush, T. O. (Naval Postgraduate School, Monterey, Calif.); Heinz, O.; Rodeback, G. W.; Cook, C. J. Rev. Sci. Instrum.; 40: 1531-41(Dec 1969).

A technique using the focusing properties of a nonuniform axially symmetric magnetic field to study large-angle ($\theta > 32°$, lab) scattering of ions from atoms and molecules is described. The scattering cell is placed on the magnetic axis at the position of maximum field and ions in the momentum interval $|\Delta p|$ at $|p|$ scattered into a conical shell $\Delta\theta$ at θ are counted by a detector placed down along the axis in a region of low field. The solid angle is increased by a factor of several hundred over conventional scattering techniques of comparable angular resolution because of the azimuthal symmetry of the apparatus. The magnetic vector potential and the trajectory equation for a charged particle in this type of inhomogeneous, axially symmetric field are derived. As a preliminary test the known differential scattering cross section for He^+ on the He was measured from 40 to 52° (lab) at 300 eV. Results of measurements of the absolute differential scattering cross sections for Li^+ on He from 36 to 41.7° at 200 and 300 eV, corresponding to cms scattering angles of 90 to 160°, are presented. (auth)

6370 ON THE CALCULATION OF TOTAL ELECTRON INELASTIC SCATTERING CROSS SECTIONS FOR NEUTRAL ATOMS IN THE keV ENERGY RANGE. Bonham, R. A.; Ng, E. W. (Indiana Univ., Bloomington). Chem. Phys. Lett.; 4: 355-7 (1 Dec 1969).

The total inelastic cross sections for electron scattering from neutral atoms are calculated by integrating the Morse inelastic intensity over all scattering angles using the Waller–Hartree values of the inelastic scattering factors given by Tavard. (auth)

6371 REACTIONS OF EXCITED ATOMS AND MOLECULES WITH ATOMS AND MOLECULES. III. RELATIVE CROSS SECTIONS FOR PENNING- AND ASSOCIATIVE IONIZATION BY $He(2^1S)$-AND $He(2^3S)$-METASTABLES. Hotop, H.; Niehaus, A.; Schmeltekopf, A. L. (Univ., Freiburg i. B.). Z. Phys., 229: 1-13(1969).

From a He beam excited by electron impact, the $He(2^1S)$ component was eliminated to better than 0.5% by irradiating light from a He discharge. The quenching process is $h\nu(2^1P \rightarrow 2^1S) + He(2^1S) \rightarrow He(2^1P) \rightarrow He(1^1S) + h\nu(2^1P - 1^1S)$. By measuring the ions produced in collisions of the He metastables with various target gases in a mass spectrometer, singlet to triplet Penning cross-section ratios were obtained. These ratios are without exception close to one, which is taken as evidence for the previously proposed electron exchange mechanism of the Penning ionization. In the case that more ions are produced in the collision of $He(2^1S)$ and $He(2^3S)$ with a target gas, separate relative production cross sections are obtained for the two metastables. For the rare gases the measurements are performed at two temperatures of the He beam, 320 and 90°K. It is found that the cross-section ratio of associative to Penning ionization increases considerably as the temperature is decreased for both $He(2^1S)$ and $He(2^3S)$, the effect being much more pronounced for $He(2^1S)$. The results of this work are found to confirm conclusions drawn from measured energy distributions of the electrons ejected in the Penning process. (auth)

6372 COINCIDENCE STUDY OF KRYPTON ION–ATOM COLLISIONS AT KILOVOLT ENERGIES. McCaughey, Michael Paul. Storrs, Conn.; Univ. of Connecticut (1969). 70p.

Thesis.

Single collisions of Kr^+ on Kr at 12 to 200 keV incident energy and from 8 to 40 degrees scattering angle are studied using coincidence techniques. Indirect evidence of inner shell vacancies in krypton is obtained. A study is made of the correlation matrix involving the charge states of both the scattered and recoil particles and it is found that there is approximate statistical independence except in the region characterized by what is thought to be the onset of inner shell vacancies. This "active region" corresponds to

a distance of closest approach of 0.4 Angstroms. The reaction under study is $Kr^+ + Kr \rightarrow Kr^{+m} + Kr^{+n} + (m + n - 1)e^-$ where m, n range from 0 to 11. The ionization probabilities and the amount of energy required to produce various m,n charge state combinations are measured for average energy losses up to 2600 eV. A study of the energy spectrum of the electrons ejected after the collision shows no sharp peak of Auger electrons. The ionization probabilities are interpreted according to a statistical model that yields intrinsic ionization curves, and these curves are used to estimate the ionization potentials of Kr^{+5} through Kr^{+9}. (Diss. Abstr. Int., B)

6373 THE PAIR EQUATION APPROACH TO THE CALCULATION OF PHASE SHIFTS FOR THE SCATTERING OF LOW-ENERGY ELECTRONS FROM HELIUM. Morris, Richard Ward. Reno; Univ. of Nevada (1968). 75p.

Thesis.

A pair approximation, applicable to scattering problems, is developed in analogy with the work of several authors on atomic structure problems. The approximation consists of replacing the three-electron Schroedinger equation by two "pair equations," each of which describes the motion of a pair of electrons. The use of pair equations makes it possible to carry out a variational calculation on the electron–helium scattering problem using a trial function that depends explicitly on the interelectronic distances. The approximation is applied to low-energy elastic scattering, and s-wave phase shifts and cross sections are calculated. The possibility of obtaining rigorous solutions of the pair equations by means of the Faddeev equations is investigated. (Disser. Abstr.)

6374 MEASUREMENT OF Ar–Kr AND Ar*–Kr INTEGRAL CROSS SECTIONS AT INTERMEDIATE ENERGIES WITH AN ARC-HEATED AERODYNAMICALLY ACCELERATED ATOM BEAM. Winicur, Daniel Henry. Los Angeles; Univ. of California (1968). 139p.

Thesis.

Relative values of the integral collision cross sections of Ar–Kr and $Ar^*(^3P)$–Kr are reported as a function of relative velocity from 1.5×10^5 to 2.6×10^5 cm/sec (0.47 to 1.4 eV). These measurements were made using an arc-heated, aerodynamically accelerated argon atomic beam and a liquid-nitrogen-cooled krypton-filled scattering chamber. The velocity dependence of the Ar–Kr cross section is compared to that obtained from a semiclassical random-phase calculation based on the Kihara potential model. The potential-energy curve obtained differs from one obtained from macroscopic data in that the curve is shifted to a larger interatomic distance. The ratio of the Ar–Kr and Ar*–Kr integral cross sections is compared to the value obtained in the absence of repulsive interatomic forces. This comparison indicates that the repulsive part of the potential-energy curve is more significant for Ar*–Kr than for Ar–Kr. The electron-impact excitation cross section of argon is measured relative to the ionization cross section over the energy range from 60 to 100 eV. Upper and lower bounds on the absolute value of these cross sections are obtained. Measurements of the fractional excitation in the arc-heated beam are compared to a previously reported result and to predictions based on the assumption of equilibrium in the plasma arc. (Disser. Abstr.)

6375 CHARGE-EXCHANGE COLLISIONS OF HYDROGEN IONS IN CESIUM VAPOR, AND OF HELIUM IONS IN CESIUM VAPOR AND PERMANENT GASES, IN THE ENERGY RANGE 0.5 TO 30 keV. Schlachter, Alfred Simon. Madison, Wis.; Univ. of Wisconsin (1969). 150p.

Thesis.

Charge-exchange collisions of He and H ions and atoms in Cs vapor were studied in the energy range 1.5 to 25 keV for He and 0.5 to 20 keV for H. Measurements of the positive, neutral, and negative beam components after passage through the target were made as a function of the Cs target thickness. For H^+ ions and fast ground-state H^0 atoms incident on Cs vapor, cross sections and the equilibrium yields were measured. The maximum equilibrium yield of H^- was found to be 0.21 ± 0.04, at an energy of 0.75 keV, making Cs an excellent charge-exchange medium for H^- ion sources. The data for He^+ ions incident on Cs vapor were analyzed using a charge-exchange model with four components, to allow for differences between He^0 atoms in singlet and triplet states. Cross sections relevant to the charge-exchange processes were determined. The fraction of He^- ions after charge exchange in Cs was found to have a maximum value at a particular Cs target thickness, rather than to monotonically approach charge equilibrium. The maximum yield of He^- ions was found to be 0.014 ± 0.001, at an energy of 6 keV, making Cs an excellent charge-exchange medium for He^- ion sources. A large difference was found in the cross sections for formation of ions from He^0 atoms in singlet states and in the triplet metastable state. This was utilized in an experiment to study single-electron pickup of He^+ in permanent gas targets (Xe, H_2, Ar, He), for energies of 5 to 30 keV. A subsequent collision of the resulting He^0 atoms in a thin Cs target was used to analyze the electronic state of the He^0 atoms. A charge-exchange model was used to determine cross sections and the fraction of He^0 atoms in the triplet metastable state after formation by electron pickup in the permanent gas target. (Disser. Abstr.)

Atomic Theory

6376 QUASI-INDEPENDENT MODEL FOR ATOMIC STRUCTURE CALCULATIONS. McNaughton, D. J.; Henry, W. G. (Queen's Univ., Kingston, Ont.). J. Phys., B (London); 2: 1131-7(Nov 1969).

A model for atomic structure calculations is proposed, which differs from the Hartree–Fock model. One half of the electronic interaction potential energy is associated with each of the two electrons involved. A best-energy criterion is applied to the one-electron energies instead of to the total energy. The ground states of the He, Ne, and Ar atoms are used as numerical examples. It is found that the one-electron energies are widely separated for the outer electrons. The sum of the one-electron energies equals the total energy to first order in perturbation theory and is a good approximation to the experimental total energy. The virial theorem is not immediately satisfied. The spin orbitals form a new orthonormal set. The electrons are closer to the nucleus on the average than those in the Hartree–Fock model. (auth) (UK)

6377 RELATIONSHIP OF THE QUASI-INDEPENDENT MODEL TO THE HARTREE–FOCK MODEL. McNaughton, D. J.; Smith, V. H. Jr. (Queen's Univ., Kingston, Ont.). J. Phys., B (London); 2: 1138-41(Nov 1969).

The one-electron energies, radial orbitals, and radial expectation values for the quasi-independent model are expressed as a scale transformation of those for the Hartree–Fock model. (auth) (UK)

6378 BEYOND THE IMPACT APPROXIMATION. Van Regemorter, H. (Observatoire de Paris, Meudon, France). Phys. Lett.; 30A: 365-6(17 Nov 1969).

A simple derivation of the impact approximation is given and a more general binary interaction theory is proposed, which is valid in the region between the impact and the static regime for isolated lines. (auth)

6379 RELATIVISTIC INFINITE-COMPONENT WAVE EQUATION FOR H ATOM WITH SPIN. Barut, A. O.; Baiquni, A. (International Atomic Energy Agency, Trieste, Italy). Phys. Lett.; 30A: 352-3(17 Nov 1969).

A relativistic infinite-component wave equation is given that describes relativistic and spin effects in the H atom correctly and accounts for recoil. In the limit $m_p \rightarrow \infty$, the spectrum coincides with that of the Dirac equation. (auth)

6380 FADDEEV APPROACH TO THREE-PARTICLE SYSTEMS WITH COULOMB INTERACTIONS. Rajagopal, A. K. (Tata Inst. of Fundamental Research, Bombay); Majumdar, C. K. Phys. Lett.; 30A: 429-30(1 Dec 1969).

The Faddeev equations are used in suggesting that low-lying "vibration" and "rotation" levels besides the three-particle bound states of a number of three-particle systems can be computed. This theory does not involve Born–Oppenheimer approximation. (auth)

6381 RELATIVISTIC AND NON-RELATIVISTIC CONFIGURATION INTERACTION CALCULATIONS FOR ATOMS HAVING A CLOSED CORE AND TWO VALENCE SPIN-ORBITALS. Beck, Donald R.; Zare, Richard N. (Univ. of Colorado, Boulder). Contracts AT(30-1)-3408; DA-31-124-ARO-D-139. Comput. Phys. Commun., 1: 113-34(Oct. 1969).

The program SOCKITTOME 1 calculates wave functions for bound atomic levels. Correlation and relativistic effects are included. The low-Z Pauli approximation, which is correct to orders $Z^3\alpha^2$ and $Z^4\alpha^2$ in the energy (the nonrelativistic energy is of order Z^2), is used to approximate the atomic Hamiltonian. The anti-Hermitian part of those operators characteristic of the Dirac theory is dropped. The program is written in FORTRAN IV for the CDC 6400. (A.G.W.)

6382 SECOND-ORDER PERTURBATION CALCULATIONS WITH CORRELATED ZERO-ORDER FUNCTIONS FOR TWO-ELECTRON ATOMS: ON THE RATE OF CONVERGENCE OF THE PERTURBATION SERIES. Jankowski, K. (N. Copernicus Univ., Torun, Poland). Acta Phys. Pol.; 36: 735-53(Nov 1969).

A perturbation procedure for two-electron systems is proposed in which correlation effects are taken into account in the zero order. It allows one to obtain, for the helium ground state, a rate of convergence for the energy series better than any other perturbation scheme. This method allowed for an investigation of the influence of poles appearing in the perturbing operator upon the rate of convergence just mentioned. Numerical results up to the fifth order in energy and second order for other expectation values are presented. (auth)

6383 SPIN-PROJECTED RANDOM-PHASE APPROXIMATION. Terasaka, T.; Matsushita, T. (Tohoku Univ., Sendai). Chem. Phys. Lett.; 4: 384-8(1 Dec 1969).

The rigorous treatment of the spin multiplicity in the random-phase approximation (RPA) is developed and expressions for the matrix B different from those in the conventional treatment are obtained. It is suggested that the imaginary transition energy for the triplet state obtained by using the conventional method may be due to the nonvanishing of the matrix B for the triplet state. (auth)

Cosmic Radiation

Refer also to abstracts 6307, 6323, 6410, 6416, and 6682.

6384 (AD-694461) EFFECTS OF SOLAR MODULATION ON THE ENERGY SPECTRUM OF HEAVY COSMIC-RAY NUCLEI. Cleghorn, T. F.; Freier, P. S.; Waddington, C. J. (Minnesota Univ., Minneapolis. Cosmic Ray Group). Aug 1969. Contract Nonr-710(60). 11p. (CR-142). CFSTI.

The intensity and energy spectrum of very-heavy nuclei ($20 \leq Z \leq 30$) are being studied in nuclear emulsions flown from Fort Churchill in 1968. In particular, it is planned to determine the form of the energy spectrum at low energies in order to study the effects of solar modulation. Provisional results of relatively low statistical weight are reported here. (auth) (USGRDR)

6385 (AD-694463) HIGH-ENERGY ELECTRON COMPONENT OF THE COSMIC RADIATION. Marar, T. M. K.; Freier, P. S.; Waddington, C. J. (Minnesota Univ., Minneapolis. Cosmic Ray Group). Jul 1969. Contract Nonr-710(60). 16p. (CR-143). CFSTI.

A composite stack of nuclear emulsions and lead sheets mounted in a spark chamber array triggered by scintillator and gas Cherenkov counters was flown to search for energetic electrons of 6 to 10 GeV. A considerable number of particles detected as primary electrons were traced into the nuclear emulsions and identified as not being electrons but particles making nuclear interactions. The number of identified electrons found corresponds to an intensity of electrons with E > GeV of $0.08 + 0.06$ or -0.04 electrons/m^2 sr.sec. (auth) (USGRDR)

6386 (KFKI-26/1969) INVESTIGATION OF THE 27 DAY PERIODICITY OF THE COSMIC RAY INTENSITY 40 m w.e. UNDERGROUND. Kota, J.; Somogyi, A.; Valas, G.; Varga, A. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1 Oct 1969. 4p. Dep. CFSTI (U. S. Sales Only).

The existence of a 27-day persistent wave was checked in the intensity of the cosmic-ray muonic component measured at a depth of 40 mwe underground at Budapest during the years 1958-1963. The maximum likelihood method with simultaneous meteorological corrections was used to analyze the data. No indication was found for either a 27- or a 27.3-day wave. (auth)

6387 (KFKI-27/1969) DENSITY SPECTRUM OF THE PENETRATING COMPONENT OF THE EXTENSIVE AIR SHOWERS. Betev, B.; Bogdanova, N.; Stanev, T.; Valas, G. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1 Oct 1969. 3p. Dep. CFSTI (U. S. Sales Only).

The exponent of the muon-density spectrum of the EAS was determined at the altitude 2925 m a.s.l. on the basis of 16,926 registered showers by means of an apparatus consisting of four hodoscoped G-M counter sets located on the corners of a 8m × 8m square under 30 cm lead. The corresponding mean number of muons in the showers was $N_\mu \geq 1.2 \times 10^6$. The method used to analyze the data made it possible to eliminate the effect of the multiplication in the lead. A value $\gamma = 2.35 \pm 0.05$ was obtained for the exponent of the spectrum. (auth)

6388 DISCUSSION OF PAPER BY W. R. WEBBER AND C. CHOTKOWSKI: A DETERMINATION OF THE ENERGY SPECTRUM OF EXTRATERRESTRIAL ELECTRONS IN THE ENERGY RANGE 70 TO 2000 MeV. Hovestadt, D. (Univ. of Chicago). J. Geophys. Res.; 74: 6521-4(1 Dec 1969).

In a series of papers Webber and collaborators have published results on the energy spectrum of cosmic-ray and atmospheric electrons. These results were based on measurements with a lead glass Cherenkov counter for energy determination of the electrons. In the absence of a direct calibration of their instrument, they used data of Heusch and Prescott (1964) to determine the energy response of the detector in relation to penetrating, highly relativistic, singly charged particles. It is suggested that this procedure has led the authors to an overestimate of their electron energy by about a factor of two. A reply by Webber is included. (W.D.M.)

6389 EMPIRICAL RESPONSE FUNCTIONS FOR A NEUTRON MULTIPLICITY MONITOR. Nobles, R. A.; Hughes, E. B.; Wolfson, C. J. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res.; 74: 6459-70(1 Dec 1969).

The results are reported of a latitude survey carried out with a neutron multiplicity monitor by which the response of each multiplicity to primary rigidities is directly calibrated. The latitude survey was carried out with a specially designed multiplicity monitor, the LMSC monitor, covering the threshold rigidity range 1.9 to 4.5 GV at mountain elevation and the range 4.5 to 15.5 GV at sea level. The data reveal directly the comparative rigidity characteristics of the various multiplicities. A general formulation is given according to which time variations in the multiplicity distribution can be converted into variations in the primary cosmic-ray rigidity spectrum. Finally, this formulation is applied to several cosmic-ray events that have occurred during the period of operation of the LMSC monitor at White Mountain, California. (auth)

6390 STRUCTURE IN THE FAST SPECTRA OF ATMOSPHERIC NEUTRONS. Wilson, John W.; Lambiotte, Jules J.; Foelsche, T. (Langley Research Center, Hampton, Va.). J. Geophys. Res.; 74: 6494-6(1 Dec 1969).

The results of a Monte Carlo transport calculation of fast neutron spectra produced by galactic cosmic-ray protons in the atmosphere are presented. These results show that definite structure in the fast neutron spectra should be observed when these measurements are made. (auth)

6391 "HYSTERESIS" EFFECT IN COSMIC RAY MODULATION AND THE COSMIC RAY GRADIENT NEAR SOLAR MINIMUM. Kane, S. R.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 74: 6247-55(1 Dec. 1969).

Cosmic-ray total ionization measurements made in space near the Earth with the OGO 1 and OGO 3 ion chambers (cutoff = 12 MeV per nucleon for protons and helium nuclei) during the period September 1964 to December 1967 are compared with other cosmic-ray measurements in space and on the ground. The findings are: (1) As compared to the recovery phase (before May 1965) the apparent long-term modulation of the low-energy (>12 MeV per nucleon) particles was relatively less during the early decreasing phase (June 1965 to December 1966) giving rise to the "hysteresis" effect. The observed effect, which was maximum (~13%) from June 30, 1966, to July 4, 1966, disappeared completely by April 22-28, 1967. (2) The hysteresis effect is probably a characteristic of the modulation mechanism. It is not likely to be due to the time variation of a quiescent flux of energetic solar particles. (3) The observations in 1964-1965 are consistent with a heliocentric gradient of ~0% per AU in the range 1.0 to 1.28 AU and probably also in the range 1.0 to 1.56 AU. (auth)

6392 AMPLITUDE-PHASE RELATION OF DIURNAL VARIATION OF COSMIC RAYS. Pak, Byung-so. (Sogang Jesuit Coll., Seoul). New Phys. (S. Korea), Suppl.; 9: No. 1, 79-83 (Nov 1969).

Using the super neutron monitor data of Deep River and Sulphur Mt. from 1963 to 1965, it is found that the amplitude-phase relation is unique in its distribution. That is, the amplitude is maximum in the theoretically predicted direction and gradually decreases toward the afternoon and morning direction. The profile of the amplitude distribution around the Earth is not a simple sinusoidal form. And a second peak locates around 43 to 58° west of Sun-Earth line for both stations. In order to pursue whether this relation could be used in a purpose of separation of the enhanced and deviated diurnal variations during the disturbed conditions from normal pattern, some discussions were given. (auth)

6393 CLIMATIC CHANGES, SOLAR ACTIVITY, AND THE COSMIC-RAY PRODUCTION RATE OF NATURAL RADIOCARBON. Suess, Hans E. (Univ. of California, San Diego). Meteorol. Monogr.; 8: 146-50(Feb 1968).

The level of the cosmic-ray-produced radiocarbon in atmospheric carbon dioxide fluctuates due to changes in the cosmic-ray intensity. These changes can be explained by considering the modulation of the galactic cosmic-ray flux by the Sun. There exists a second independent correlation of the fluctuations of the

radiocarbon level with changes in the climate. This correlation can best be recognized from climatic data as given by Lamb for the time since the 10th century A.D. The two kinds of correlations promise to provide a key to the understanding of solar-climatic relationships in general. The carbon-14 measurements so far carried out show that prolonged high solar activity leads to warm winters, and periods of a quiet Sun lead to cold winters in Europe and elsewhere. There is reason to believe that future determinations of carbon-14 variations during the past 6000 to 8000 yr may supply conclusive evidence regarding the causes for the great ice ages. (auth)

6394 HAVE THE DIFFUSE COSMIC X RAYS AN ANISOTROPIC COMPONENT. O'Connell, R. F.; Verma, S. D. (Louisiana State Univ., Baton Rouge). Nature (London); 224: 505-6(1 Nov 1969).

A large anisotropy was predicted (O'Connell and Verma Phys. Rev. Lett. 22: 1443(1969)) for these rays; this appeared to be at variance with experimental data, which indicated isotropy to within about 10%. More recent measurements (Cooke, Griffiths, and Pounds, Nature 224: 134(1969)) have, however, provided evidence in support of anisotropy. Excess x rays were observed from the region of the galactic equator in the 1.4 to 18 keV region, with an intensity of 0.3 photons $(cm^2\ S\ rad)^{-1}$ near $l = 200°$, increasing to 0.5 near $l = 300°$ in the Centaurus region. These results may indicate that the diffuse x rays result from two separate mechanisms, one producing an isotropic component and the other an anisotropic component. The predictions mentioned above are examined in the light of these new results. (UK)

6395 SOLAR COSMIC-RAY BURST OF JANUARY 28, 1967. Kaminer, N. S.; Miroshnichenko, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 269-71(1969).

Translated from Geomagn. Aeron.; 9: 336-8(1969).

A cosmic-ray burst was recorded by neutron monitors at about 8 h 30 m UT on January 28, 1967. The maximum increase at Vostok Station did not exceed 40%. The burst was observed at stations with a cutoff rigidity $R \lesssim 4.5$ BeV. Data for the burst are given. (M.O.W.)

6396 EXTENSIVE AIR SHOWERS OF COSMIC RAYS. Jatczak, J. (Univ. of Lodz, Poland). Postepy Astron.; 2: 77-93(1968). (In Polish).

The extensive air showers of cosmic rays arising as the result of the interaction of primary particles with nuclei of elements in the atmosphere are discussed. The diffusion equations for the photon–electron and nuclear cascades that describe the evolution of the shower are presented. The experimental data regarding the photon–electron, the muon, and the nuclear-active components are given. (auth) (NSA of Poland)

6397 FLUCTUATION PHENOMENA DURING THE PROPAGATION OF RELATIVISTIC SOLAR PROTONS IN THE INTERPLANETARY MAGNETIC FIELD. Shishov, V. I. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.): 9: 178-82(1969).

Translated from Geomagn. Aeron.; 9: 222-7(1969).

The propagation of relativistic solar protons in a random magnetic field is examined on the assumption that the characteristic dimension of magnetic field inhomogeneities is much smaller than the Larmor radius of a proton. An equation for the second moment of the distribution function, characterizing the intensity fluctuations of relativistic protons, is obtained from the collisionless kinetic equation. A solution of this equation is found for weak intensity fluctuations. Theoretical results are compared with experimental data on the intensity fluctuations of relativistic protons during cosmic-ray flares. (auth)

6398 CHARACTERISTICS OF THE INTERPLANETARY MAGNETIC FIELD, ACCORDING TO DATA ON SEMIDIURNAL COSMIC-RAY VARIATIONS. Krivoshapkin, P. A.; Krymskii, G. F.; Kuz'min, A. I.; Skripin, G. V. (Inst. of Cosmophysical Investigations and Aeronomy, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 183-8(1969).

Translated from Geomagn. Aeron.; 9: 228-35(1969).

Cosmic-ray distribution within regular magnetic tubes of circular and rectangular cross section is examined. This distribution is represented by the second spherical harmonic. The expected patterns of semidiurnal and asymmetric diurnal cosmic-ray variations are computed for various orientations of the interplanetary magnetic field with respect to the sun–earth line and the plane of the ecliptic. The cosmic-ray distribution spectrum is found and the characteristics of the interplanetary magnetic field are determined. (auth)

6399 DEPENDENCE OF COSMIC-RAY INCREASES PRIOR TO FORBUSH EFFECTS ON THE STRUCTURE OF THE INTERPLANETARY MAGNETIC FIELD. Dorman, L. I.; Kaminer, N. S.; Kebuladze, T. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 174-7(1969).

Translated from Geomagn. Aeron.; 9: 217-21(1969).

It is demonstrated that the increase in cosmic-ray intensity prior to Forbush decreases depends on the solar longitude of chromospheric flares and on the velocity of the solar wind. The results obtained agree with the assumption that the increase is produced by the azimuthal component of the interplanetary magnetic field. (auth)

6400 PRIMARY COSMIC-RAY ELECTRONS AND ALBEDO ELECTRONS IN 1967 AT ENERGIES BETWEEN 12 AND 1000 MeV. Israel, Martin Henry. Pasadena, Calif., California Inst. of Tech., 1969. 142p.

Thesis.

The flux of cosmic-ray electrons was measured in a series of high-altitude balloon flights. Balloons launched from Fort Churchill, Manitoba, on June 17, July 2, July 9, and July 21, 1967, floated near $2 g/cm^2$ atmospheric depth; and one launched from Palestine, Texas on April 7, 1967, floated near $5 g/cm^2$. The detector system included a threshold gas Cherenkov counter, a digital spark chamber with lead plates, and scintillation counters. During the flight of July 9, the detector was pointed toward the nadir to observe the splash albedo. The resulting energy spectrum and also the return albedo spectrum observed in the April flight are presented. In the other three flights, the diurnal variation near the polar cap of the flux of downward-moving electrons with energy $\lesssim$100 MeV was observed. The nighttime flux is significantly lower than the splash albedo, while the daytime flux is in good agreement with the splash albedo. This comparison lends strong support to the model in which the low nighttime flux consists of primary electrons and atmospheric secondaries, while in the daytime the primaries are replaced by return albedo. It was found that the nighttime geomagnetic cutoff near 68° geomagnetic latitude is below 17 MV, and the daytime cutoff is between 70 and 110 MV. Making use of the analysis of the diurnal variation, the primary electron spectrum was examined. The observed flux of electrons with energy above the local geomagnetic cutoff and below 350 MeV is consistent with the expected flux of atmospheric secondaries; 2σ upper limits were derived to the primary electron flux of 20, 9, and 13 electrons/m^2 sec sr in the intervals 17 to 57, 57 to 112, and 112 to 374 MeV, respectively. 16 ± 14 electrons/m^2 sec sr between 374 and 1060 MeV were found. Comparison between the observed primary flux and the calculated flux of galactic secondary electrons indicates an absolute solar modulation of electrons below 100 MeV by at least a factor of three. (Disser. Abstr.)

Direct Energy Conversion

Refer also to abstracts 5829, 6179, 6582, and 6583.

6401 (AD-693153) INVESTIGATION OF A LARGE SCALE NONEQUILIBRIUM MAGNETOHYDRODYNAMIC GENERATOR. Annual Report, August 1, 1968–July 31, 1969. Zauderer, B. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Aug 1969. Contract Nonr-3867(00). 37p. CFSTI.

Efforts of the past contract year are briefly summarized. The following tasks were completed: (a) development of a uniform preionization system; (b) large-scale MHD power generation in a nonequilibrium plasma; (c) development of appropriate gas and plasma diagnostic methods for use in the MHD generator; (d) development of a theoretical model to describe the generator performance; and (e) utilization of the above results to design and construct a new MHD channel. (auth) (USGRDR)

6402 (FEI-152) STUDY OF TRANSITION PROCESSES IN A CONFINED CESIUM PLASMA. Volkov, N. V.; Gus'kov, Yu. K. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1969. 17p. (In Russian). Dep. CFSTI.

A study is made of the reaction of cesium vapor and a diode with a pulsed anode voltage. The nature of the output is determined in the steady state for the basic modes of the diode, which are differentiated in sign by the near-electrode jumps in potential and by the presence of a distributed process. The times for reaching steady state are measured as functions of temperature and pressure in the ranges from 10^{-3} to 2 torr and from 1000 to 1500°K. The characteristic features of relaxation time and the relation of this time to physical processes in the plasma are discussed. (auth)

6403 ANALYTICAL STUDIES OF THERMIONIC CONVERTER PERFORMANCE. Wilkins, D. R. (General Electric

Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 12: 405-6 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6404 DIRECT-ENERGY CONVERSION COURSE IN A NUCLEAR CURRICULUM. Backus, Charles E. (Arizona State Univ., Tempe). Trans. Amer. Nucl. Soc., 12: 426(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Fluid Physics

6405 HYDROMAGNETIC WAVES IN AN IDEALLY CONDUCTING MEDIUM WITH A TWO-DIMENSIONAL INHOMOGENEOUS MAGNETIC FIELD. Bajwa, G. S.; Srivastava, K. M. (Univ. of Jodhpur, India). Indian J. Phys.; 43: 72-5(Feb 1969).

Possibility of the propagation of hydromagnetic waves is explored in an ideally conducting incompressible fluid mass immersed in a two-dimensional inhomogeneous magnetic field. The magnetic field lies in a plane perpendicular to the surface of the fluid and varies along the normal to the above plane. Because of the absence of the boundary conditions, it is not possible to get a dispersion relation. If the components of the magnetic field are linearly related and its pressure decays exponentially, it is found that the hydromagnetic waves propagate for all values of the wave number and frequency. (auth)

6406 TURBULENT FLOW IN THE PLANE PERPENDICULAR TO THE MAGNETIC FIELD. Branover, H. H.; Vasil'ev, A. S. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 73-6(Apr.-June 1969). (In Russian).

Semi-empirical theory was constructed for conducting fluid flow in a plane perpendicular to the magnetic field in a channel with rough walls. Turbulent flow in a magnetohydrodynamic Reynolds equation is described by a Prandtl equation in which the mixing points are represented as functions of Stewart number. The problem was resolved using an electronic computer. Theoretical and experimental data on the resistance factor were correlated, and the rate of turbulent shearing stress was calculated. (R.V.J.)

6407 RADIATION MAGNETOHYDRODYNAMIC EFFECTS ON THE UNSTEADY COUETTE FLOW. Oh, Sin K. (Catholic Univ. of America, Washington, D. C.). New Phys. (S. Korea), Suppl.; 9: No. 1, 7-13(Nov 1969).

The problems of unsteady state fluid flow in a heat and electrically conducting radiating viscous fluid in the presence of a uniform magnetic field lead to a second, or fourth-order nonlinear partial differential equation for which no analytical solution has been found. A stable numerical procedure is developed for solving the equations for the constant temperatures of the two plane parallel plates. It is shown that the solutions can be reducible to that of the steady case as the time approaches infinity, and to that of the nonmagnetic field as the Hartmann number or the electric field parameter becomes zero. The results indicate that the Hartmann number or the electric field parameter assists the flow to reach its steady state, and the effect of the radiation parameters on the temperature distributions in the presence of magnetic field is more significant than that without magnetic field. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 5953, 6324, 6328, 6341, and 6399.

6408 (AD-693860) IONOSPHERIC PROBING WITH LONG WAVELENGTH RADIO WAVES. Crain, C. M. (RAND Corp., Santa Monica, Calif.). Sep 1969. 26p. (P-4185). CFSTI.

Techniques of ionospheric probing using ground-based facilities and frequencies in the region from about 10 Hz to 100 kHz including the elf, vlf, and lf portions of the spectrum are discussed. Primary emphasis is placed on vlf and lf probing; however for some purposes the elf portion of the spectrum has promise. Probing techniques at these frequencies involve measuring one or more parameters of a radio signal such as amplitude, phase, transmission time, and polarization as received at locations near (vertical or steep incidence sounding) or at distances of hundreds or thousands of kilometers from (oblique sounding) a radiation source. The radiated signal can be provided either by conventional or special-purpose pulsed or continuous-wave sources or by radiation from lightning strokes. (auth) (USGRDR)

6409 (AD-694365) COMPARISON OF COLUMNAR IONOSPHERIC ELECTRON CONTENT OBTAINED FROM SIMULTANEOUS MEASUREMENTS OF FARADAY ROTATION AND DOPPLER SHIFT. Research and Development Technical Report, Arendt, P. R. (Army Electronics Command, Fort Monmouth, N. J.). Sep 1969. 34p. (ECOM-3170). CFSTI.

A comparison of columnar content values calculated from Doppler slope and polarization data is given. Measurements were obtained simultaneously from radio beacon signals transmitted by the S-66 BEC satellite at 40, 41, and 360 MHz. The error of the Doppler method is 5%; the error of the polarization method is 3%. The ratio of the columnar content values varies between 0.75 and 1.22; larger deviations are related to horizontal gradients which affect mainly the precision of the Doppler data evaluation. (auth) (USGRDR)

6410 THE D-REGION AT SUNRISE AND AT A SMALL HEIGHT OF THE SUN. Nestorov, Georgi. Izv. Geofiz. Inst., Bulg. Akad. Nauk.; 12: 5-28(1968). (In Bulgarian).

It is demonstrated that cosmic radiation of a galactic origin in the high atmosphere and the rapid changes of the factor of the negative ions λ cause rise effects in the lower part of the D region. A detailed analysis is made of the essential changes of λ and the factors which determine it in the period mentioned, such as temperature, background photodetachment, etc. The author solves a balance equation of the α type and obtains the time drift of electron concentration at a given height. This makes possible the determination of the N(z,t) profiles in the D region at sunrise. It was established that the basic source of ionization in the period after sunrise is cosmic radiation. It is also shown that in the period $100° > x > 85°$, at heights $z > 60$ km no quasi-equilibrium exists, whereas at $z < 60$ to 55 km quasi-equilibrium exists throughout the 24-hour period. The method described allows the determination of the numerical values of all basic parameters of the D region at sunrise. An opportunity is offered for the first time for the numerical determination of the divergent member in the balance equation. The theoretical N(z) profiles obtained adjust well to the data from observations. (Abstr. Bulg. Sci. Lit.)

6411 BALANCE OF THE KINETIC PROCESSES IN THE IONOSPHERE. Serafimov, Kiril. Izv. Geofiz. Inst., Bulg. Akad. Nauk.; 12: 29-56(1968). (In Bulgarian).

The most probable processes of ionization, neutralization, and overcharge in the ionosphere are examined. Diurnal changes depending on the energy of the photon changes of the photodissociation coefficient, are established. A detailed examination is made of the kinetic processes in the various ionosphere parts and the corresponding accurate balance equations are deduced. The quasi-equilibrium distributions of the corresponding ion concentrations are determined. General balance equations for positive and negative ions and the electronic concentration are also deduced, determining on their basis the two fundamental independent equations for the electron concentration and the coefficient of the negative ions λ. These fundamental equations essentially differ from those used so far. As a result of the analysis made, new expressions are obtained for the dissociative, ionic, and radiative recombination in gas mixtures and the corresponding dependences between the effective and equivalent recombination coefficients. It is concluded that the mean effective components of these coefficients vary with the temperature and with the change of the ion composition. It is recommended that the balance equations be used for the specific kinetic processes in studying the microprocesses in the ionosphere, since the effective recombination coefficient gives only a general idea of the phenomena which are taking place. (Abstr. Bulg. Sci. Lit.)

6412 ON THE CHANGES OF THE COEFFICIENT OF NEGATIVE IONS IN THE IONOSPHERE. Serafimov, Kiril. Izv. Geofiz. Inst., Bulg. Akad. Nauk.; 12: 57-64(1968). (In Bulgarian).

A new equation describing the changes of the coefficient of negative ions λ is deduced on the basis of the author's earlier studies. Certain simplifications are made on the grounds of the uneven participation of the different ion components in ion recombination, concerning the stability of the relationship between the concentration of positive ions O_2 and electron concentration, etc. As a result, instead of the Rikatiev equation hitherto used, a linear differential equation is deduced and its integration is demonstrated. (Abstr. Bulg. Sci. Lit.)

6413 EXCITATION AND RADIATIVE TRANSPORT OF OXYGEN RESONANCE RADIATION IN THE DAYGLOW AND AURORAS. Strickland, Douglas Jerry. Pittsburgh; Univ. of Pittsburgh (1968). 127p.
Thesis.

The initial rate of excitation of the $^3S_1$ state of atomic oxygen was calculated for both the aurora and dayglow. Techniques of radiative transfer applicable to optically thick media were employed; the basis for the calculations is provided by experimental

height profiles of the 1304 Å intensity. Analysis of the auroral 1304 Å excitation rate in conjunction with 3914 Å data indicates the possibility of a strong internal electric field below 120 km. An alternative to this suggestion, however, may be time-dependent effects in the auroral electron flux. The dayglow 1304 Å excitation rate indicates that the dominant source of excitation is internal to the medium rather than the 1304 Å resonance solar source. Analysis of the applied tranfer theory also shows that pure absorption by molecular oxygen should be included in the problem (as it was in this work) if important contributions to the excitation rate exist below 120 km. Temperature effects, both in the Doppler width and in the relative populations of the ^3P fine structure levels of atomic oxygen, are also shown to produce significant differences from one temperature model to another. (Diss. Abstr.)

6414 THE MEASUREMENT OF THE DISTRIBUTION OF MAGNETIC NOISE IN THE MAGNETOSPHERE FROM 1 TO 1000 Hz AND ITS RELATIONSHIP TO ELECTRON PITCH-ANGLE SCATTERING. Russell, Christopher Thomas. Los Angeles; Univ. of California (1968). 221p.

Thesis.

The distribution of elf magnetic fluctuations, as determined from the spectrum analyzer outputs of the OGO-3 search coil magnetometer, for one and one-half years of continuous data, is presented. The data are classified into two categories: steady noise and bursts and the occurrence rate of each category is presented for all local times, for L values out to twelve earth radii, and for magnetic latitudes from the equator to 60°. Steady noise is found to be stronger and more common on the dayside of the magnetosphere. It is also only common at the equator for L values less than 6. At high magnetic latitudes on the dayside beyond L = 6, steady noise is also common. Bursts are most common beyond L = 6 near the equator. Their highest rate of occurrence occurs near 1100 local time. The whistler loss-cone instability, or equivalently, Doppler-shifted cyclotron resonance with wave growth supported by pitch-angle anisotropy maintained by the loss cone, can explain the occurrence of these bursts, electron microbursts, and chorus. It may explain the steady noise at low L values, also, but it cannot explain the high-latitude, high L-value steady noise. Both the waveform and the spectrum analyzer outputs are used to survey the near equatorial regions from 1 to 1000 Hz. Here, signals are found confined within a few degrees of the equator, and propagating perpendicular to the magnetic field lines, at frequencies of the order of 10 times the proton gyro frequency, at L values from 3 to 6. These waves have the proper characteristics to produce sufficient pitch-angle scattering to explain the observed behavior of electrons with almost flat pitches. The observed distributions of steady noise and bursts are also compared with measurements of hiss and chorus made at the feet of the field lines, both below and above the ionosphere. The comparisons show that the ground station and low-altitude satellite measurements do not always adequately reflect the noise distributions in the near equatorial regions due to absorption in the magnetosphere, and also in the ionosphere in the case of ground stations. (Diss. Abstr.)

6415 ELECTRON IMPACT CROSS SECTIONS FOR CO_2. Strickland, D. J.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Geophys. Res.; 74: 6415-24(1 Dec 1969).

Using the concept of the generalized oscillator strength and the techniques previously developed, a diverse body of experimental data on carbon dioxide is synthesized into a set of analytical electron impact cross sections. The generalized oscillator strengths of Lassettre and Shiloff (1965) serve as the primary data. Discrete excitation autoionization, direct ionization, and dissociative ionization are included in the analysis. Dissociation is implicitly included in the discrete cross sections, and its possible importance at large energy loss is discussed. The ultimate object of the work is the final set of cross sections represented by workable analytic forms that may be readily applied to dayglow and planetary aeronomy. (auth)

6416 DISCUSSION OF PAPER BY M. A. SHEA: A COMPARISON OF THEORETICAL AND EXPERIMENTAL COSMIC-RAY EQUATORS. Cain, Joseph C. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 74: 6518-20(1 Dec 1969).

Recently Shea (1969) made a comparison between the observed cosmic-ray equator and that calculated from the Finch and Leaton (1957) and the Jensen and Cain (1962) geomagnetic-field models. Shea's choice of field models is questioned. A reply by Shea is included. (W.D.M.)

6417 SOME OBSERVATIONS ON ENERGETIC ELECTRONS IN THE OUTER VAN ALLEN ZONE DURING AURORAL SUBSTORMS IN RELATION TO OPEN AND CLOSED FIELD LINES. Rao, C. S. R. (Univ. of Iowa, Iowa City). J. Geophys. Res.: 74: 6513-17(1 Dec 1969).

Some data are presented that indicate that the latitude of the onset of auroral substorm activity is inside the high-latitude boundary of trapped outer Van Allen zone electrons, implying thereby that such an onset occurs on closed lines. (W.D.M.)

6418 AN APPARENT CORRELATION BETWEEN THE h'(f) AT 2.2 MHz AND A HIGH POWER TRANSMISSION AT 4.5 MHz. Palatucci, G. J.; Gibbons, J. J.; Lee, H. S.; Ferraro, A. J. (Pennsylvania State Univ., University Park). J. Geophys. Res.; 74: 6507-12(1 Dec 1969).

Radio propagation experiments were conducted to detect the generation of sum or difference frequency waves in the ionosphere by simultaneously illuminating a region with two separate transmitters (4.5 MHz and 2.2 MHz). A number of long-exposure photographs of ionospheric echoes revealed that the effective height of reflection of the 2.2-MHz echoes appeared to be correlated with the on-time of the high-power (4.5 MHz) transmitter. An explanation was sought for this peculiar behavior, and experiments performed to investigate this phenomenon in more detail are described. (W.D.M.)

6419 MAGNETOIONIC MODE COUPLING IN SATELLITE TRANSMISSIONS NEAR THE TRANSVERSE REGION. Basu, Sunanda (Jadavpur Univ., Calcutta); Basu, S. J. Geophys. Res.; 74: 6502-6(1 Dec 1969).

The possibility of magnetoionic mode coupling in satellite transmissions through the ionosphere at 40 Mc was investigated. It was established that for a low-geomagnetic-latitude station like Calcutta (12°N geomagnetic) it is possible to have strong coupling between the characteristic modes of polarization. Using typical profiles of electron concentration, it was found that the extent of the coupled region is larger at night than during daytime. This mode coupling introduces errors in the values of total electron content determined by the Faraday rotation technique; the maximum error incurred is 5% during the day and 15% during the night. (auth)

6420 F-REGION TEMPERATURES OVER PALO ALTO IN 1967 AND 1968. Bates, Howard F.; Baron, Murray J. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res.; 74: 6497-6501(1 Dec 1969).

The SRI Thomson scatter radar obtained F-region electron and ion temperatures and electron concentrations during a number of five-day periods in 1967 and 1968. At sunrise, the electron temperature at the F-layer maximum rose abruptly from approximately the ion temperature and reached a value of about three times the ion temperature an hour or two after sunrise. On all of the days sampled in 1967 (mostly fall days), and most of those in 1968, the electron temperature in the F layer dropped rapidly after its sunrise maximum, and reached approximate thermal equilibrium in the region around the F-layer maximum near local noon. On the remainder of the days in 1968, the electron temperature stayed high throughout the day. Electron temperatures exhibited a strong inverse relationship with electron concentrations. The midday height of the F-layer maximum over Palo Alto was generally above 300 km on the observing days. (auth)

6421 DEUTERIUM IN THE EARTH'S EXOSPHERE. Bruner, E. C. Jr.; Wilson, T. E. (Univ. of Colorado, Boulder). J. Geophys. Res.; 74: 6491-3(1 Dec 1969).

Signal averaging techniques, applied to high resolution spectra of the solar Lyman-alpha line, have revealed a weak absorption feature in the short wavelength wing of the line. The position and shape of this feature suggest that it be identified as the Lyman-alpha transition in deuterium. Assuming this identification and a Doppler profile, a three-parameter fit to the data yields a central wavelength of 1215.346 A, a temperature of 1150°K, and an optical depth of 0.05. The temperature and optical depth thus found imply an enrichment factor of about 180 for the H/D ratio at 160 km, when compared with the natural abundance at the Earth's surface. (auth)

6422 RESONANT COMPRESSIONAL WAVES IN THE GEOMAGNETIC TAIL. Siscoe, G. L. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). J. Geophys. Res.; 74: 6482-6(1 Dec 1969).

Irregularities in the solar wind can excite compression waves in geomagnetic tail that have their maximum amplitude in the plasma sheet. Details such as the exact frequency and spatial distribution of the waves depend on the over-all geometry of the tail. Estimates of these properties are obtained by use of a single-layered, two-dimensional model. Symmetric and antisymmetric modes are studied. For the physical parameters chosen to represent the "typical" tail, the fundamental period of the antisymmetric mode is approximately 11 minutes and that of the symmetric mode is approximately 2 minutes. Other properties are discussed. (auth)

6423 VLF PHASE DISTURBANCES, HF ABSORPTION, AND SOLAR PROTONS IN THE EVENTS OF AUGUST 28 AND SEPTEMBER 2, 1966. Potemra, T. A.; Zmuda, A. J.; Haave, C. R.; Shaw, B. W. (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res.; 74: 6444-58(1 Dec 1969).

The vlf phase disturbances and hf absorption observed during the proton events of August 28 and September 2, 1966, were quantitatively connected to the proton intensities, energies, and cutoff latitudes observed by satellite 1963-38C, at 1100 km in a polar orbit. The connection is achieved through considerations that include a model of the ionospheric D region described in terms of an effective recombination coefficient related to the four generalized ionic reactions. The complementary use of the vlf and hf observations tends to reduce ambiguities often present in the formation of D-region models. The vlf is the more sensitive indicator of ionization effects due to solar protons in comparison to the hf absorption (especially at night) because the vlf responds to ionization enhancements over a relatively narrow altitude range varying with the proton energies and intensities. (auth)

6424 TOPSIDE RAY TRAJECTORIES NEAR THE UPPER HYBRID RESONANCE. McAfee, J. R. (ESSA Research Labs., Boulder, Colo.). J. Geophys. Res.; 74: 6403-8(1 Dec 1969).

Ray trajectories near the upper hybrid resonance show both similarities to and important differences with calculations near the resonance at the plasma frequency. As long as the upper hybrid frequency is less than the second harmonic of the electron cyclotron frequency, ray paths almost identical to those calculated near the plasma frequency can return energy to a satellite moving through the topside ionosphere. An additional type of ray path is also found. When the upper hybrid is greater than the second harmonic, the returning ray paths are not found. This is consistent with the observed resonance strength. The possibility of return paths near the frequency where the Bernstein mode disappears is also found. (auth)

6425 PROTONOSPHERIC ELECTRON CONCENTRATION PROFILES. da Rosa, A. V. (Stanford Electronics Labs., Calif.); Garriott, O. K. J. Geophys. Res.; 74: 6386-6402(1 Dec 1969).

The local electron concentration was calculated along portions of the orbit of OGO 1, based on "differential Doppler frequency" and Faraday polarization rotation measurements of harmonic radio beacon transmissions. Since it is not possible to make these calculations with sufficient accuracy for most satellite orbits, an extensive error analysis is included, to establish the sources and magnitudes of the uncertainties in the computations. Order-of-magnitude improvement over satellites in low earth orbit is achieved with the very eccentric orbit of OGO 1 and by using a combination of Faraday and differential Doppler techniques. Values of protonospheric electron concentration were obtained between altitudes of about 6000 and 15,000 km on a number of orbits. The uncertainties in the computed values result principally from scaling errors in the Faraday polarization rotation angle and from horizontal gradients in the ionosphere; they typically total less than ±600 electrons/cm^3. A number of concentration profiles are shown and are compared with direct probe measurements, with whistler results, and with extrapolated values of electron concentration obtained from Alouette 1 near 1000 km. (auth)

6426 WHISTLER-MODE EMISSIONS ON THE OGO 1 SATELLITE. Dunckel, N.; Helliwell, R. A. (Stanford Univ., Calif.). J. Geophys. Res.; 74: 6371-85(1 Dec 1969).

Magnetospheric observations of whistler-mode emissions were made by the OGO 1 satellite over the frequency range 0.3 to 100 kHz. Taken during the geomagnetically quiet period from September 1964 through May 1965, the data cover geocentric distances from 2 to 24 R_E and geomagnetic latitudes in the range ±50°. Emissions are found within $L \sim 10$ at all local times except for $L > 5$ in the midnight-to-dawn sector, with intensity peaking at $L \sim 4$ and $L \sim 9$ near 10 hours local mean time. Their spectra resemble those of chorus and midlatitude hiss observed on the ground. An important new result is the observation that the upper-frequency limit of most of these emissions is proportional to the minimum electron gyrofrequency along the magnetic fieldline passing through the satellite. This is interpreted to mean that the source of these emissions lies close to the equatorial plane. Estimates of the average intensity of these emissions agree with the intensity required to explain the precipitation of electrons through pitch-angle scattering by whistler-mode waves. Emissions observed on the dayside beyond $L = 8$ are burst-like, and their occurrence tends to decrease with increasing radial distance. The location of the maximum intensity in this region agrees with that found for 1-keV electron fluxes, giving strong support to theories of generation based on electron cyclotron resonance. No emissions were observed beyond the estimated position of the shock boundary. (auth)

6427 NONDUCTED MODE OF VLF PROPAGATION BETWEEN CONJUGATE HEMISPHERES; OBSERVATIONS ON OGO's 2 AND 4 OF THE "WALKING-TRACE" WHISTLER AND OF DOPPLER SHIFTS IN FIXED FREQUENCY TRANSMISSIONS. Walter, F.; Angerami, J. J. (Stanford Univ., Calif.). J. Geophys. Res.; 74: 6352-70(1 Dec 1969).

Evidence for nonducted vlf propagation between conjugate hemispheres was found in records from the broadband vlf receivers aboard the polar satellites OGO 2 (419 to 1521 km) and OGO 4 (412 to 908 km). The nonducted signals described here are received in the ionosphere between 47° and 56° invariant latitude. They have never been observed on the ground and include natural whistlers and fixed-frequency signals (10.2 to 12.5 kHz) from the Omega transmitters. In a time-frequency spectrogram, these nonducted whistlers appear as rising tones with a lower cutoff frequency in the approximate range of 5 to 8 kHz. They have been named "walking-trace" (WT) whistlers, since a rapid increase in travel time as a function of satellite latitude causes successive examples of the rising trace to "walk through" other whistlers having equal dispersions and produced by the same sequence of lightning sources. A train of WT whistlers exhibits a nearly constant lower cutoff frequency that is equal to the maximum value of the lower hybrid resonance (LHR) frequency above the satellite and an upper cutoff frequency that decreases with increasing satellite latitude. Reflected waves following a WT whistler can also be received if the LHR frequency below the satellite reaches values greater than above it. Observed spectral shapes of such whistlers resemble a fishhook. Fixed-frequency Omega signals observed by OGO 4 in the hemisphere conjugate to the transmitter frequently have characteristics similar to those of the WT whistlers. The Omega signals exhibit two features that are not apparent in the natural whistlers: an enhancement of signal strength and a Doppler shift that increases with latitude and may reach hundreds of hertz. The main characteristics of the above phenomena are explained by tracing nonducted rays between conjugate hemispheres in a model magnetosphere. An equatorial electron concentration profile is derived from the WT whistlers. (auth)

6428 VLF STEP FREQUENCY SOUNDING OF THE POLAR LOWER IONOSPHERE. Helms, Ward J.; Swarm, H. Myron (Univ. of Washington, Seattle). J. Geophys. Res.; 74: 6341-51(1 Dec 1969).

The lower ionosphere above Byrd Station, Antarctica, was probed using radio waves over the frequency range 3.0 kHz to 30 kHz. A new phase radar technique was used to determine an accurate phase height of reflection for a propagation path near vertical incidence. The results of the first seven months of synoptic sounding of the polar D region are presented. The analysis of these data has yielded the average phase height behavior during periods of total darkness, continuous sunlight, and day-night, night-day transition, under both quiet and disturbed magnetic conditions. The dominant ionization production mechanism is related to energetic particle precipitation and is only slightly affected by solar ultraviolet radiation. Phase height measurements obtained during a large polar cap absorption event are also shown. (auth)

6429 HIGH-LATITUDE PLASMA TRANSPORT: THE POLAR WIND. Banks, Peter M.; Holzer, Thomas E. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 74: 6317-32(1 Dec 1969).

Within the polar regions of the Earth, magnetic field lines do not form closed loops but are open to the tail of the magnetosphere and interplanetary conditions. Owing to the low plasma pressure in the tail, outward transport of ionospheric plasma takes place with H^+ and He^+ reaching supersonic speeds at 2000 to 5000 km altitude. The loss of light ions from the topside polar ionosphere leaves O^+ as a dominant ion to great altitudes and results in very low ambient electron concentrations. Typical escape fluxes calculated for H^+ and He^+ are in the ranges 2 to 7×10^8 cm^{-2} sec^{-1} and 2 to 4×10^6 cm^{-2} sec^{-1}, respectively. When magnetospheric convection is taken into account, the escape of ionospheric plasma can lead to the formation of a sharp latitudinal density gradient (the plasmapause) at the boundary between corotating and convecting magnetic field lines. Owing to the outward flow of ionospheric plasma, the magnetospheric tail is populated with ions of terrestrial origin such that the proton/helium ion ratio lies in the range 100 to 400. (auth)

6430 FEATURES OF PLASMA TRANSPORT IN THE UPPER ATMOSPHERE. Banks, Peter M.; Holzer, Thomas E. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 74: 6304-16(1 Dec 1969).

Problems relating to steady, ambipolar flow of plasma are discussed with application to the terrestrial ionosphere. It is shown that steady flow, either accretion or escape, must be a

general condition in the absence of a constraining magnetic field and that diffusive equilibrium results only for one particular value of the asymptotic boundary plasma pressure. With regard to plasma escape, subsonic and supersonic flows act to reduce ion densities below the values found for diffusive equilibrium. The usual diffusion equation appropriate to low-speed plasma transport leads to two linearly independent density distributions corresponding to diffusive equilibrium and full flow. For any model, linear combinations of these two solutions must be used to match density and velocity boundary conditions. The equations appropriate to high-speed plasma transport are developed, and boundary conditions appropriate to supersonic and subsonic flow are discussed. (auth)

6431 DIRECT MEASUREMENTS OF THE SIZE AND AMPLITUDE OF IRREGULARITIES IN THE TOPSIDE IONOSPHERE. Dyson, P. L. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 74: 6291-6303(1 Dec 1969).

Data obtained from the Alouette 2 Langmuir probe experiment during a 3-month period in the fall of 1966 have been examined for effects due to electron concentration irregularities (fine structure). Irregularities occur in patches hundreds of kilometers in horizontal extent, and individual irregularities have amplitudes between 5% (limit of resolution) and 70% and dimensions of less than 2 km along the satellite path. These irregularities appear more often at night than during the day, and they occur in a region that contains the auroral oval and extends to both higher and lower latitudes. Comparison of the probe data with Alouette 2 ionograms obtained simultaneously shows that spread F occurred at the height of the satellite whenever fine structure was observed. However, particularly at midlatitudes, spread F often occurs at the satellite even when the probe does not detect irregularities. When spread F occurs, but the probe does not observe fine structure, the irregularities are less than 5% in amplitude (i.e., below the probe's resolution). Calculations using an irregularity model indicate that spread F is often caused by irregularities less than 0.5 km thick. Several irregularity production mechanisms that could account for the results are discussed. (auth)

6432 DAYTIME MIDLATITUDE ION COMPOSITION MEASUREMENTS. Hoffman, J. H.; Johnson, C. Y.; Holmes, J. C.; Young, J. M. (Naval Research Lab., Washington, D. C.). J. Geophys. Res.; 74: 6281-90(1 Dec 1969).

An Argo D-4 (Javelin) rocket was launched from Wallops Island, Virginia, at 1828 GMT, Aug. 15, 1966, to rendezvous with a pass of the Explorer 31 and Alouette 2 satellites. The rocket reached an altitude of 720 km while the satellites were at 970 km. Identical magnetic mass spectrometers on the rocket and Explorer 31 satellite measured the composition of the ionosphere while the Alouette 2 topside sounder provided electron concentration profiles. Ten different ion species were observed. O^+ is the dominant constituent from 200 km to 1000 km with H^+ 5% and He^+ less than 1% of the O^+. The chemical equilibrium relation between H^+ and O^+ gives a value for the neutral hydrogen concentration of 6.2×10^4 at 250 km and a neutral gas temperature of 940°K. From the He^+ concentration at 400 km a rate coefficient for the He^+ loss reaction with N_2 of 1.2×10^{-9} cm^3 sec^{-1} is calculated. The NO^+ and O_2^+ scale heights from 200 to 300 km agree with those of N_2 and O_2 giving credence to the ion chemistry involved. In comparing the results from this rocket flight with those of other types of mass spectrometers flown in a similar time period, it is seen that the major discrepancy lies in the n(H^+) measurements, the present result being lowest. The in-flight calibration tends to indicate that a mass spectrometer is more sensitive to light mass ions than to O^+. This phenomenon may account for the discrepancy noted. (auth)

6433 TWO-DIMENSIONAL CHAPMAN–FERRARO PROBLEM WITH NEUTRAL SHEET. 3. IMPLIED MAGNETOSPHERIC FLOWS AND THEIR TIME DEPENDENCE. Atkinson, G.; Unti, T. (Jet Propulsion Lab., Pasadena, Calif.). J. Geophys. Res.; 74: 6275-80(1 Dec 1969).

In a magnetosphere with a magnetic tail and a perfect neutral sheet, the steady-state field line configuration is found to depend on two variables: the magnetic flux in the tail and the solar wind momentum flux. Thus, changes in solar wind momentum flux, or transport of magnetic field lines into and from the tail cause a large-scale magnetospheric flow toward the new equilibrium configuration. The solutions to the two-dimensional case are used to study the flows and indicate the following: (1) changes of the momentum flux of the solar wind are important in producing convective flow, only if they are an order of magnitude in a short time; (2) the large-scale convective flow is usually determined to first order by the rate at which field lines are being carried into the tail and is probably not dependent on occurrences at the neutral sheet; and (3) reconnection and collapse of tail field lines to a dipolar-like configuration could produce significant magnetosphere-wide flow only if it was burst-like in occurrence. The magnetospheric response to forces that produce flows depends on the relative size of three time constants: The time constant of the driving force, the time to set up a stressed magnetosphere, and the time to relax it by motion of field line feet through the conducting ionosphere. (auth)

6434 AURORAL LYMAN-ALPHA OBSERVATIONS. Clark, M. A.; Metzger, P. H. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 74: 6257-65(1 Dec 1969).

Lyman-alpha auroral emissions during January and February 1967 were observed. The observations were made with a narrow band sky-scanning photometer mounted on an Earth-oriented satellite in polar orbit. Auroras in the southern hemisphere were usually single in structure, whereas those in the north were complex. The single auroral emissions show a typical latitude spread of about 6.5°. Intensities up to 60 kR were observed at times of high magnetic activity, implying energy deposition up to 20 ergs cm^{-2} sec^{-1}. The intensities show a correlation with high-latitude geomagnetic activity, with a breakdown during extremely active periods. (auth)

6435 RELATION OF SOLAR PROTON LATITUDE PROFILES TO OUTER RADIATION ZONE ELECTRON MEASUREMENTS. McDiarmid, I. B.; Burrows, J. R. (National Research Council of Canada, Ottawa). J. Geophys. Res.; 74: 6239-46(1 Dec 1969).

Charged-particle detectors on the Alouette 2 satellite were used to study various features of solar proton (1 to 8 MeV) latitude profiles during relatively quiet magnetic conditions. One feature of these profiles that is observed frequently is a flux enhancement close to the cutoff latitude for these particles. The high-latitude limit of the enhancement, denoted by Λ_c, shows a good correlation with Λ_b, the background boundary for outer-zone electrons (E > 35 keV). The region of enhanced flux, when it occurs, usually extends down to the latitude cutoff or "knee," which exhibits approximately the same dependence on local time as Λ_c (or Λ_b) but is displaced 6 or 7° toward lower latitudes. Arguments are given that indicate the enhanced fluxes occur on closed field lines, and it is suggested that solar protons from the tail scatter across closed field lines and the flux enhancements may result from small differences in the probabilities for scattering into and out of the closed field line region. The position of the latitude "knee" as a function of local time and the pitch-angle distributions close to the "knee" are discussed in relation to cutoff theories. (auth)

6436 IONOSPHERIC AERODYNAMICS. Gurevich, A. V.; Pitaevskii, L. P.; Smirnova, V. V. (Lebedev Inst. of Physics, Moscow). Space Sci. Rev.; 9: 805-71(Sep 1969).

The following topics are discussed: (1) basic equations and law of similarity, (2) flow past a semi-plane, (3) flow of plasma, containing a mixture of ions, past a semi-plane, (4) flow past a wedge, (5) flow past the rounded edge of a body, (6) flow past a plate, (7) flow past a cylinder, (8) flow past a disc, (9) influence of an electric field on the motion of the ions, (10) flow past highly elongated bodies, (11) plasma instability in the trail of a moving body, (12) the potential of the body's surface, (13) numerical calculations taking account of a finite Debye radius, (14) experimental investigations of the disturbed zone in the vicinity of rockets and satellites in the ionosphere, and (15) scattering of radio waves by a disturbed zone in the vicinity of a layer with $\epsilon = 0$. (M.O.W.)

6437 CONJUGATE POINT PROBLEMS. Oguti, Takasi (Tokyo Univ.). Space Sci. Rev.; 9: 745-804(Sep 1969).

Review-type discussions are given for the following: (1) definition of conjugate points and conjugate phenomena, (2) possibilities of temporal displacement of conjugate points, (3) tracers of the conjugate field lines, (4) display of phenomena at conjugate stations, (5) modulation of conjugate effects, (6) conjugate relation with satellite observation, (7) significance of conjugate research, and (8) future problems. (M.O.W.)

6438 SMALL-ENERGY PLASMA IN THE MAGNETOSPHERE OF THE EARTH. A REVIEW. Gringauz, K. I. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 1275-1310(1969). (In Russian).

A brief review is given of the data on low-energy plasma in various magnetosphere regions. The plasma characteristics (in particular, its distribution) vary with the geomagnetic perturbations. This holds for plasma in the peripheral part of the ionosphere and for plasma distributed over the plasmapause. 110 references. (R.V.J.)

6439 PARTICLES AND FIELDS: SIGNIFICANT ACHIEVEMENTS. 2. Schardt, Alois W.; Opp, Albert G. (National Aeronautics and Space Administration, Washington, D. C.). Rev. Geophys.; 7: 799-849(Nov 1969).

Satellite observations of energetic particles and magnetic fields during the last years have contributed greatly toward understanding our environment. Studies of nonadiabatic processes that occur in the radiation belts have led to a qualitative understanding of several source and loss mechanisms responsible for the observed particle population. A plasma instability leading to spontaneous emission of vlf and elf waves has been found that limits the maximum flux of protons and electrons that can be trapped in the geomagnetic field. It has been shown that diffusion of particles into the magnetosphere is accompanied by a gain in particle energy; this process probably accounts for most of the lower-energy particles found in the Van Allen belts. A comprehensive description of the geomagnetic field has been completed. Corrections for the current systems at the magnetospheric boundary and in the magnetotail have been applied in a comprehensive model. Secular changes in the main field have been interpreted in terms of core motion in the Earth. Initial measurements have been performed of the galactic cosmic-ray gradient in the solar system between Venus and Mars. Theories for explaining this gradient in terms of observable properties of the solar wind are being perfected. The relative abundance and energy spectra of hydrogen and helium isotopes in cosmic radiation have been explained in terms of interstellar matter traversed by the cosmic-ray particles. (auth)

6440 ION–ACOUSTIC WAVES IN THE AURORAL PLASMA. Hofstee, J.; Forsyth, P. A. (Univ. of Western Ontario, London). Can. J. Phys.; 47: 2797-2803(15 Dec 1969).

Two coherent bistatic radio systems were used to observe auroral radio reflections under geometrical conditions which would favor the detection of ion–acoustic waves in the auroral ionization. The displaced "line" spectrum characteristic of scattering by ion–acoustic waves was a prominent feature of some of the observations but the strength of the wave-scattered component varied widely relative to the nonwave-scattered components. It is concluded that ion–acoustic waves do indeed occur in the auroral plasma but that such waves cannot be the only source of radio-wave scattering in aurora. (auth) (Canada)

6441 INTERACTION BETWEEN AN ELECTRON FLUX AND THE ATMOSPHERE. Osipov, N. K.; Pivovarova, N. B.; Pivovarova, V. G.; Timoshenko, L. F. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 276-8(1969).

Translated from Geomagn. Aeron.; 9: 344-6(1969).

The following quantities were computed as a function of height for the height interval 90 to 160 km: (1) the ionization function, (2) luminosity in the 3914 Å line and the integral intensity of the light flux of this emission, (3) electron concentration, and (4) the radio wave absorption coefficient at various frequencies and integral absorption. (M.O.W.)

6442 ELECTRIC FIELDS IN THE AURORAL IONOSPHERE. Osipov, N. K.; Pivovarov, V. G.; Romashchenko, Yu. A. (Inst. of Cosmophysical Investigations and Aeronomy, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 278-9 (1969).

Translated from Geomagn. Aeron.; 9: 347-8(1969).

The relationship between horizontal electric fields and the parameters of charged-particle fluxes in the region of visible auroral forms is examined. The fact was used that the regions of electron and proton flux injection coincide, although their relative position depends significantly on magnetic activity and has a diurnal pattern. (M.O.W.)

6443 RELATIONSHIP BETWEEN E_s AND VERTICAL MOVEMENTS OF IONIZED FORMATIONS. Vasil'ev, K. N.; Krutikova, T. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 285-6(1969).

Translated from Geomagn. Aeron.; 9: 353-4(1969).

Data are given showing that the limiting E_s frequency increased as an ionized formation passed from the F- to the E-region. (M.O.W.)

6444 POSSIBLE METHOD FOR COMPUTING RADIO WAVE ABSORPTION IN THE LOWER IONOSPHERE. Ryss, I. K.; Chernysheva, S. P. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 287-8(1969).

Translated from Geomagn. Aeron.; 9: 355-6(1969).

Simultaneous use of vertical sounding data and of data on complete absorption, obtained by the A1 method, makes it possible to determine radiowave absorption in the lower ionosphere. The method is briefly considered here. (M.O.W.)

6445 VARIATION IN THE AVERAGE LENGTH OF AURORAL RAYS IN THE COURSE OF A NIGHT (TIXIE BAY). Dzyubenko, N. I. (Kiev State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 290(1969).

Translated from Geomagn. Aeron.; 9: 358(1969).

Three curves of auroral emissions are given, length of the emissions being plotted against time for one night. All three curves are identical leading to the conclusion that the average length of auroral rays decreases gradually in the evening hours in the Tixie Bay area and, after reaching a minimum at ~20 h LT (~11 h UT), it increases monotonically until morning twilight. (M.O.W.)

6446 CHARACTERISTICS OF THE MAGNETIC STORM OF SEPTEMBER 14, 1966, ACCORDING TO OBSERVATIONS IN THE TAIL OF THE MAGNETOSPHERE AND AT THE SURFACE OF THE EARTH. Ivanov, K. G.; Mikerina, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 291-2(1969).

Translated from Geomagn. Aeron.; 9: 359-60(1969).

Data taken from earth stations and from Explorer 33 in the magnetotail are compared. The diagrams are described. (M.O.W.)

6447 RELATIONSHIP BETWEEN HIGH-LATITUDE GEOMAGNETIC DISTURBANCES AND ELECTRON FLUXES AT THE BOUNDARY OF THE OUTER RADIATION BELT. Khorosheva, O. V.; Darchieva, L. A.; Lopatina, G. B. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 292-4(1969).

Translated from Geomagn. Aeron.; 9: 361-2(1969).

A quantitative estimate was made of the geomagnetic effectiveness of sporadic electron fluxes observed at the boundary of trapped radiation. Elektron 1 and Elektron 2 data for February–March 1964 were used. Cases were selected when the usually sharp belt boundary, determined from electrons with E > 100 keV, was diffuse or burst peaks were observed at the boundary or directly behind it. The shape of the belt boundary is shown in diagrams. Energy flux spectral curves of the electrons are also shown. (M.O.W.)

6448 SUDDEN DISAPPEARANCE OF TYPE Pc2-4 GEOMAGNETIC PULSATIONS. Troitsakaya, V. A.; Shchepetnov, R. V.; Gul'el'mi, A. V. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 294-6(1969).

Translated from Geomagn. Aeron.; 9: 363-5(1969).

The effect of a sudden interruption in magnetic Pc2–4 pulsations after a negative impulse, si^-, is shown. It is found that this phenomenon is global: the pulsations cease. Conditions under which the pulsations disappear were analyzed. The state of the ionosphere does not play a significant role in this process. A sudden magnetic field impulse si^- appears when the geomagnetic cavity expands rapidly. If the radius of the magnetosphere after an si^- exceeds some critical value, then, according to the formula developed, instability stops and Pc2–4 pulsations cease. (M.O.W.)

6449 RESULTS OF SYNCHRONOUS OBSERVATIONS OF GEOMAGNETIC PULSATIONS ON THE TERRITORY OF THE USSR. Al'perovich, L. S.; Berdichevskii, M. N.; Van'yan, L. L.; Kocharyants, E. B. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 297-9(1969).

Translated from Geomagn. Aeron.; 9: 366-8(1969).

Synchronous observations of the horizontal components of geomagnetic pulsations were made on August 1, and September 1, 1966. The records were taken with static magnetometers with photoelectronic amplification. The sensitivity of the recording channels was thousands of γ/mm at a tape speed of 60 mm/min. Experimental results do not contradict the idea that the pulsations are the result of resonances of outer geomagnetic tubes; however, to clarify the mechanism, observations would have to be made in the auroral zone on which these force tubes rest. (M.O.W.)

6450 COMPLEX OF SCIENTIFIC EQUIPMENT ON COSMOS 137 FOR THE STUDY OF RADIATION IN NEAR-EARTH SPACE. Savenko, I. A.; Savun, O. L.; Shavrin, P. I. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 189-94(1969).

Translated from Geomagn. Aeron.; 9: 236-43(1969).

The purpose of investigations and the requirements imposed on equipment for the study of radiation in near-earth space are formulated. A block diagram of the equipment installed on Cosmos 137 is presented. A brief description is given of the detectors and of the method of telemetering the information. (auth)

6451 INFLUENCE OF THE HORIZONTAL GRADIENTS OF THE PARAMETERS OF ELECTRON DENSITY DISTRIBUTION ON THE MUF, HOP DISTANCES, AND ANGLES OF ARRIVAL. Kovalevskaya, E. M.; Kornitskaya, E. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 232-4(1969).

Translated from Geomagn. Aeron.; 9: 290-5(1969).

The MUF and angles of arrival, computed with allowance for the horizontal inhomogeneity of the ionosphere and for a spherically stratified ionosphere, are compared. The necessity of accounting

for the horizontal inhomogeneity of the ionosphere in computations of various radio communications characteristics is demonstrated. (auth)

6452 DYNAMICS OF THE AURORAL ZONE AND RADIO WAVE PROPAGATION AT HIGH LATITUDES. Kukushkina, R. S.; Pudovkin, M. I.; Starkov, G. V. (Polar Geophysical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 235-8(1969).
Translated from Geomagn. Aeron.; 9: 296-8(1969).

Radio-wave propagation at three frequencies on a link crossing the auroral zone is examined. The character of the reflection is determined from the change in the probability of radio-wave transmission at various frequencies and the parameters of the ionosphere are estimated for various magnetic disturbance levels. Analysis of the diurnal probability pattern substantiates the presence of a discontinuity in the auroral zone in the morning. (auth)

6453 DISPLACEMENT OF THE AURORAL BAND. Shabanskii, V. P. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 239-48(1969).
Translated from Geomagn. Aeron.; 9: 299-309(1969).

The displacement and broadening of the auroral band as a result of various magnetic field disturbance sources distant from the earth are examined. The auroral band is interpreted as a transitional region from the core to the tail of the magnetosphere. The displacement of the auroral band is computed using the equality of magnetic fluxes through the surface of the earth and the equatorial plane for the region of the magnetosphere with closed lines of force of the field. The idea of a dynamic equilibrium (between the core and the tail of the magnetosphere), realized in the continuous processes of connection and disconnection of magnetic lines of force, is used to determine the behavior of the auroral band on the night side. (auth)

6454 MOTION OF LOW-ENERGY CHARGED PARTICLES IN A MODEL MAGNETOSPHERE WITH A CONSTANT ELECTRIC FIELD. Samokhin, M. V. (Radio Engineering Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 155-60(1969).
Translated from Geomagn. Aeron.; 9: 193-9(1969).

The trajectories of average drift and the period of oscillations between mirror points of low-energy charged particles moving in a dipole magnetic field and in a constant electric field perpendicular to the dipole moment are investigated on the assumption of the conservation of the two adiabatic invariants. It is demonstrated that the character of particle motion and, particularly, the form of the average drift trajectory and the location of the mirror points depend significantly on the coordinates of the injection point into the magnetosphere (local time and geomagnetic latitude). (auth)

6455 TANGENTIAL DISCONTINUITY IN THE SOLAR WIND AND A GROUND MAGNETIC DISTURBANCE. Ivanov, K. G.; Mikerina, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 161-4(1969).
Translated from Geomagn. Aeron.; 9: 200-4(1969).

It is demonstrated that the discontinuity in the solar wind, observed on the Vela 2A satellite, can be represented explicitly as tangential. The magnetic disturbance at the earth, produced by this discontinuity, is investigated. It is shown that ionospheric currents also contribute to the disturbance, along with currents at the magnetosphere boundary and earth currents. Note is made of the anomalous deformation of the geomagnetic field by surface currents on the day side of the magnetosphere; this is probably caused by the violation of the normally assumed condition of the conservation of the geomagnetic field $2\rho u^2 \sin^2(uH) = H^2/8\pi$. The global ionospheric current system consists of two branches, night and day, with marked polar and equatorial electrojets. (auth)

6456 SOME CHARACTERISTICS OF THE RELATIONSHIP BETWEEN INTERVALS OF PULSATIONS OF DECREASING PERIOD WITH IONOSPHERIC DISTRUBANCES. Troitskaya, V. A.; Mal'tseva, N. F. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 249-51(1969).
Translated from Geomagn. Aeron.; 9: 310-14(1969).

It is demonstrated that intervals of pulsations of decreasing period (PDP) are observed during magnetic storms in periods of sharp temporary increases in magnetic activity. Brief (15 to 30 min) complete absorption events or sporadic layers of auroral type are observed at the same time in the auroral zone. Ionospheric disturbances in the F region, observed at middle latitudes after PDP, increase. (auth)

6457 AIRGLOW VARIATIONS IN THE REGIONS 2500 TO 3150 A, ACCORDING TO COSMOS 92 OBSERVATIONS. Krasnopol'skii, V. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 165-8(1969).
Translated from Geomagn. Aeron.; 9: 205-10(1969).

Curves of the airglow intensity pattern in the interval 2500 to 3150 Å on eight passes of Cosmos 92 are presented. (auth)

6458 SOLAR-TERRESTRIAL PHYSICS: TERRESTRIAL ASPECTS. Proceedings of Joint IQSY/COSPAR Symposium, London, July 1967. Part II. Stickland, A. C. (ed.). Annals of the IQSY (International Years of the Quiet Sun). Volume 5. Cambridge, Mass.; Massachusetts Institute of Technology Press (1969). 468p. $22.50. (CONF-670729-(Pt.2)).

The present volume of the Annals of the IQSY is the second of the two volumes containing the papers presented at the Joint IQSY/COSPAR Symposium held in London in July 1967. The first volume of symposium material covered the solar and interplanetary aspects, and the present volume contains papers on the terrestrial aspects: meteorology, the ionosphere, the Earth's atmosphere, and geomagnetism. (W.D.M.)

6459 CONJUGATE POINT EFFECT OBSERVED FOR ELECTRON TEMPERATURES IN THE 1000 TO 2500 km HEIGHT RANGE. Wrenn, G. L.; Shepherd, G. G. (University Coll., London). J. Atmos. Terrest. Phys.; 31: 1383-9(Dec. 1969).

Langmuir probe data from the Explorer 31 satellite were analyzed for electron temperature with the local ionosphere in darkness and varying degrees of solar illumination at the conjugate point. The magnetic field line passing through the spacecraft was traced back to the Earth, in both directions. The solar depression angles at the intersections of this field line with the 300 km level were calculated. Data were accepted only for the situation where one intersection was in darkness and the other under partial illumination. The electron temperatures so selected were found to increase from 1400 to 2400°K as the conjugate solar depression angle decreased from 8 to 0°. This enhancement was remarkably insensitive to large changes of altitude, latitude, or longitude of the spacecraft. (auth) (UK)

6460 THE MEASUREMENT OF A LUNAR TIDE IN THE PHASE HEIGHT OF THE E REGION. Butcher, E. C.; Weekes, K. (Univ. of Exeter, Eng.). J. Atmos. Terrest. Phys.; 31: 1421-34(Dec 1969).

The measurements of the lunar tidal influence on the group height of radio waves reflected in the E region made by Appleton and Weekes (1939) and others have given rise to problems of interpretation. An attempt to determine the corresponding lunar influence on the phase height of reflection is described in the hope that this would give some help in the interpretation. Measurements were made of the daily change of phase path for a continuous wave (2.5 MHz) reflected at oblique incidence in the E region and the results were analyzed to reveal the lunar tide. The resultant tide appears to be statistically significant, although it is not as well determined as wished in the limited set of data. The interpretation of the results in terms of an electromagnetic drift theory relating them to the lunar current flow is examined and the conditions under which such an explanation may be satisfactory are established. (auth) (UK)

6461 INTERMEDIATE IONOSPHERIC LAYER AT HIGH LATITUDES. French, A. G. (DSIR, Christchurch, New Zealand). J. Atmos. Terrest. Phys.; 31: 1435-8(Dec 1969).

The behavior of an intermediate ionospheric layer at high latitudes, its relationship to geomagnetic and auroral activity, and its continuity with the F-region are discussed briefly. (auth) (UK)

6462 FIELD ALIGNMENT OF SMALL IONOSPHERIC IRREGULARITIES. Titheridge, J. E. (Univ. of Auckland, New Zealand). J. Atmos. Terrest. Phys.; 31: 1439-44(Dec 1969).

All transits of the satellites BeB and BeC observed over a period of 3 yr were examined to find cases when the angle between the ray path and the magnetic field in the ionosphere became less than 10°. The amplitude and polarization scintillations occurring under these conditions were compared with the scintillations occurring, on the same transits, when the ray path made an angle of 30° to the magnetic field. In general the results showed only a slight tendency to field alignment, with a mean axis ratio for the irregularities of about 2 or 3 to 1. The field alignment is greatest near local midnight, and almost disappears in the afternoon. On 10% of the transits the scintillations increased greatly near the longitudinal point, showing the occasional existence of highly elongated irregularities. (auth) (UK)

6463 LOW LATITUDE vlf EMISSIONS AND POLAR SUBSTORMS. Harang, L. (Norwegian Defence Research Establishment, Kjeller); Akasofu, S.-I. J. Atmos. Terrest. Phys.; 31: 1445-8(Dec 1969).

It is shown that low-latitude vlf emissions observed in morning–forenoon hours in the subauroral zone are closely associated with the occurrence of polar substorms. (auth) (UK)

6464 SECULAR VARIATION IN F REGION RESPONSE TO SUNSPOT NUMBER. Muggleton, L. M. (Univ. of Edinburgh). J. Atmos. Terrest. Phys.; 31: 1413-19(Dec 1969).

A long-term oscillatory variation was detected in the relationship between F-region ionization and visible solar activity. The dominant component appeared to be a cosine term of period equal to four sunspot cycles. The last crossing of the zero line appears to have occurred during the 1947–1948 sunspot maximum, making that epoch of importance to statistical methods designed to remove this secular variation from ionospheric studies. (auth) (UK)

6465 TEMPORAL BEHAVIOR OF ENERGY INJECTION INTO THE GEOMAGNETIC RING CURRENT. Davis, T. Neil (Univ. of Alaska, College). J. Geophys. Res.; 74: 6266-74(1 Dec 1969).

The rate of energy injection into the geomagnetic ring current was determined for the years 1958 and 1964 using a method based on Dst and knowledge of the decay rate for the ring current energy. At all levels of magnetic activity, the temporal behavior of the energy injection is similar to Dp in that it is burst-like; also there is a positive but imperfect correlation between Dp and the rate of energy injection into the ring current. The onset times of energy-injection bursts typically occur during the same hour or after the onset times of Dp bursts, and it is often possible to identify an injection burst as being associated with a particular Dp burst and then the peaks in both types of activity are simultaneous within one hour. During the quiet year of 1964, the average injection rate, on a monthly basis, was fairly constant and was near 1.2×10^{17} ergs sec^{-1}. The rate during the active year 1958 was highly variable with the over-all average being 1.7×10^{17} ergs sec^{-1}. Maximum hourly average injection rates of 1×10^{19} ergs sec^{-1} occurred during great magnetic storms. Although the injection of energy into the ring current, averaged over the entire ring, increases during a magnetospheric substorm, examination of longitudinal differences in the injection indicate temporary losses from the midnight and morning sectors at the onset of some substorms. Also it is found that when a magnetic storm follows a prolonged period of magnetic quiet, there is often precursor activity lasting 4 to 60 hours. (auth)

6466 DESIGN, CONSTRUCTION, AND OPERATION OF A PLASMA WIND TUNNEL. Condit, William Chapin Jr. Ithaca, N. Y.; Cornell Univ. (1968). 142p.

Thesis.

An experimental apparatus was designed to simulate the flow of the "solar wind" over the earth's magnetosphere. The collisionless shock wave in front of the earth was of particular interest. A wind tunnel using a coaxial arc jet as the plasma source was selected over other devices as offering the best chance to set up a steady flow over a model "Earth." It was found that the power required decreased with increasing tunnel size, so that a large tunnel was desirable. One was constructed using an available vacuum vessel of 1.6-m diameter and 6-m length. Measurements were performed on the plasma to establish its properties. Microwave interferometry and Langmuir probes were used to get approximate values of the electron density. A bolometer and a ballistic pendulum were used to measure the time-integrated energy flux and momentum flux. The plasma density and velocity inferred from these measurements were in agreement with the microwave and probe measurements. By deflecting the charged particles away from the bolometer and the pendulum with a magnetic field, it was established that the neutral density was less than 15% of the plasma density. By spectroscopic methods the plasma was found to be at least 75% pure hydrogen, and most likely considerably purer than that. Using a series of bolometers at different radial positions in the jet, the plasma properties were found to have a strong radial dependence. This was shown experimentally to be related to the length of the cathode insulator. It is argued that, by adjusting this length, the radial dependence can be made less severe. It is concluded that the plasma properties are suitable for the study of collisionless shock waves in this device. (Disser. Abstr. Int., B.)

6467 A MODEL OF THE PLASMA SHEET IN THE EARTH'S MAGNETOSPHERE. Forslund, David Wallace. Princeton, N. J.; Princeton Univ. (1969). 290p.

Thesis.

The linear, low-frequency, unstable normal modes of a realistic model of the plasma sheet in the Earth's magnetic tail including anisotropic electron and ion temperatures are considered, using the Vlasov–Maxwell equations. The equilibrium model is a sheet pinch in which the magnetic field and plasma pressure depend on only one coordinate and in which the magnetic field goes through zero. A class of equilibrium solutions of the Vlasov–Maxwell equations is found in which the scale length of the thickness of the plasma sheet and the scale length of the much thinner magnetically neutral sheet can be adjusted to agree with the satellite observations. Possible connection of the magnetic field across the neutral surface, as appears to be indicated by the experiments, is not considered in this equilibrium. The normal mode perturbations of this equilibrium described by the time-dependent Vlasov–Maxwell equations are studied for frequencies lower than that of the longest characteristic particle period and wavelengths longer than the largest characteristic particle orbit. The equations for these normal modes yield the low-frequency dispersion relation for a weakly inhomogeneous, finite β plasma. For the strongly inhomogeneous plasma sheet the normal modes for propagation parallel and perpendicular to the magnetic field are studied. For propagation parallel to the magnetic field, unstable modes arise from a weak electron temperature anisotropy ($T_\perp > T_\parallel$), which can have a much faster growth rate than the linear magnetic merging or tearing mode. For propagation perpendicular to the magnetic field in the plane of the sheet, a sequence of overstable normal modes related to the magnetic drift wave are found. In the presence of a weak electron temperature anisotropy ($T_\parallel > T_\perp$) the modes become localized about the neutral surface with the growth rate of the even modes greatly enhanced by the resonance of electrons in the crossing particle region while the growth rate of the odd modes remains controlled only by resonant ions. These modes provide a mechanism for accelerating particles along the magnetic field lines since, in contrast to the case of parallel propagation, the electric field is parallel to the equilibrium magnetic field. Since these drift anisotropy modes become very unstable at just the anisotropy needed to stabilize the tearing mode, a weak electron temperature anisotropy can not stabilize the plasma sheet although it can change the type of instability and the mechanism of particle acceleration. (TSS) (Disser. Abstr. Int., B.)

Low-Temperature Physics

Refer also to abstracts 5950, 6203, and 6284.

6468 (LA–4104-tr) ELECTRON MECHANISM OF SUPERCONDUCTIVITY IN SEMICONDUCTORS AND SEMIMETALS. Geilikman, B. T.; Kresin, V. Z. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Fiz. Tekh. Poluprov.; 2: 764-7(1968). 4p. Dep. CFSTI.

A discussion of the possibility of an electron mechanism of superconductivity in semiconductors, semimetals, and molecular crystals is presented. (auth)

6469 (NYO–4060-2) A STUDY OF THE INTERACTION BETWEEN MAGNETIC FLUXOIDS AND CRYSTAL DEFECTS IN TYPE II SUPERCONDUCTORS. Informal Progress Report. Kramer, E. J. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 31 Oct 1969. Contract AT(30-1)-4060. 12p. Dep. CFSTI.

The apparatus for measurements of stress relaxation by plastic flow in lead alloy crystals at 4.2°K was constructed and calibrated. Theoretical studies aimed at a unified treatment of both surface and bulk pinning are reviewed. A brief account of the most important elements of a model that accounts successfully for the initial experimental results is given. Preliminary results on niobium single crystals with flat surfaces, which tend to support the proposed model, are presented. (MHR)

6470 EFFECT OF THE SUPERCONDUCTING TRANSITION IN LEAD SINGLE CRYSTALS ON THE CRITICAL SHEAR STRESS. Pustovalov, V. V.; Startsev, V. I.; Fomenko, V. S. (Physicotechnical Inst. for Low-Temperature, Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 11: 1119-21(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1382-4(May 1969).

Pure Pb single crystals, with their extension axis close to the [110] direction, were loaded within a superconducting solenoid with a magnetic field of 1400 Oe (normal state) or zero field (superconducting state). The critical shear stress was measured at 1.5 to 14°K; it was found to be higher in the normal state than in the superconducting state, and the maximum difference occurred at 4.2°K. It is concluded that the anomalous temperature dependence of the critical shear stress is due to the superconducting transition. (D.L.C.)

6471 RELIABILITY OF STABILIZED SUPERCONDUCTING MAGNETIC SYSTEMS. Sychev, V. V.; Zenkevich, V. B.; Kremlev, M. G.; Al'tov, V. A. (Inst. of High Temperatures, Moscow). Dokl. Akad. Nauk SSSR; 188: 83-5(1 Sep 1969). (In Russian).

In systems which include superconducting and normal components, the marked temperature dependence of the resistance of the normal components, such as copper or aluminum, affects the transition process of the magnetic system from the superconducting to the normal state. Methods used for evaluating the reliability of such combined conductors do not take into account the effect of temperature gradients. This problem was studied by determining the volt–ampere characteristics of combined super-

conducting and normally conducting systems containing copper, with the conductivity ratio of the latter metal of $\rho_{300°K}/\rho_{4.2°K}$ = 100. The value of the stability parameter α was standardized under conditions of bubble formation in the liquid helium. It was found that above a certain current I* in the volt–ampere diagram, the stable state of the normal conductor is impossible; under certain conditions transition to the normal state results in an increase of the temperature of the conductor and loss of stability. Thus, consideration of the temperature dependence of the normal metal allows one to determine the conditions needed for the safe and reliable operation of the stabilized system on the basis of known parameters of the components. (TTT)

6472 EQUILIBRIUM PROPERTIES OF A SUPERFLUID SEPARATOR FOR ENRICHING THE CONCENTRATION OF ^{3}He. Listerman, Thomas W. (Monsanto Research Corp., Miamisburg, Ohio). J. Chem. Phys.; 51: 4330-5(15 Nov 1969).

The equilibrium properties of a superfluid separator for enriching the concentration of ^{3}He in a liquid ^{3}He–^{4}He solution were investigated. Measurements were made at selected temperatures above 1°K and at equilibrium vapor pressures throughout the entire range of attainable ^{3}He concentrations. The data were grossly describable by classical thermodynamics using previously reported experimental data in the calculations. Small systematic deviations between the thermodynamic predictions and the measurements were observed. These deviations agree with those observed by London, Clarke, and Mendoza. [Phys. Rev. 128: 1992(1962)]. (auth)

6473 LOW-TEMPERATURE SPECIFIC HEAT OF CRYSTALLINE SPECIMENS OF V_3Si. Bonnerot, J.; Hallais, J.; Barisic, S.; Labbe, J. (Faculte des Sciences, Orsay, France). J. Phys. (Paris); 30: 701-13(Aug-Sep 1969). (In French).

Specific heat measurements on the series of nonstoichiometric polycrystalline compounds are compared to the predictions of the Labbe–Friedel tight binding model. On varying the most important parameter of the theory, the occupation number of the almost empty d sub band, a reasonable agreement between predicted and observed behavior of the electronic specific heat and superconducting transition temperature is obtained. The disagreement with the normal BCS theory is discussed through the failure of the law of corresponding states. (auth)

6474 PULSES INDUCED IN TUNNELING CURRENTS BETWEEN SUPERCONDUCTORS BY ALPHA-PARTICLE BOMBARDMENT. Wood, G. H.; White, B. L. (Univ. of British Columbia, Vancouver). Appl. Phys. Lett.; 15: 237-9(15 Oct 1969).

A superconducting tunnel junction was bombarded with alpha particles and the resulting pulses in the quasi-particle tunneling current were observed. The possibility of utilizing this effect in nuclear spectrometry is discussed. (auth)

6475 DOMAIN STRUCTURE OF TRAPPED FLUX IN TYPE-II SUPERCONDUCTORS. Huebener, R. P.; Kampwirth, R. T.; Rowe, V. A. (Argonne National Lab., Ill.). Phys. Lett.; 30A: 385-6(1 Dec 1969).

Trapped flux in thin foils of type-II superconductors shows a domain structure with regions of opposite flux arranged in the specimen. As in a ferromagnetic body, the domains are established in order to reduce the total energy of the system. (auth)

6476 EVIDENCE FOR A SECOND ENERGY GAP IN SUPERCONDUCTING NIOBIUM. Hafstrom, J. W.; Rose, R. M.; Macvicar, M. L. A. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett.; 30A 379-80(1 Dec 1969).

Tunneling measurements on superconducting Nb single crystals indicate the existence of a second energy gap for superconductivity, about $1/10$ the width of the larger one, and independent of temperature between 0.48 and 4.2°K. (auth)

6477 SUPERCONDUCTING TUNNEL JUNCTIONS WITH A NONCONVENTIONAL INSULATOR. Faraci, G.; Giaquinta, G.; Mancini, N. A. (Univ., Catania, Italy). Phys. Lett.; 30A: 400-1(1 Dec 1969).

A method of forming tunnel junctions, employing a thin film of plastic material as insulator, is discussed. Lead energy gap measurements exhibit good agreement with BCS theory prediction. (auth)

6478 FREQUENCY DEPENDENCE OF THE ENHANCED DIAMAGNETISM ABOVE THE SUPERCONDUCTING TRANSITION POINT. Koyanagi, M.; Tsuzuki, T. (Kyushu Univ., Fukuoka). Phys. Lett.; 30A: 405-6(1 Dec 1969).

The frequency dependence of the enhanced diamagnetic susceptibility due to the fluctuation of the superconductivity order parameter is calculated microscopically in the classical range of temperature above the transition point. (auth)

6479 RESISTANCE ANOMALY AT THE TRANSITION OF TYPE-I SUPERCONDUCTING THIN FILMS IN MAGNETIC FIELDS. Ogushi, T.; Onodera, Y.; Shibuya, Y. (Kyushu Univ., Fukuoka). Phys. Lett.; 30A: 406-7(1 Dec 1969).

In magnetic fields above the critical field H_c, an excess resistance over the normal one was observed for type-I Sn films. (auth)

6480 ATTENUATION OF ELASTIC SURFACE WAVES IN THIN-FILM SUPERCONDUCTING Pb AND In AT 316 MHz. Akao, F. (Osaka Univ.). Phys. Lett.; 30A: 409-10(1 Dec 1969).

The attenuation of elastic surface waves in thin films (about 1000 Å) of the superconductors, In and Pb, at a frequency of 316 MHz was measured as a function of temperature below the critical temperature. There is no steep-falling character of (α_s/α_n) at T_c, although a surface wave generates a shear strain in the films. The temperature dependence of (α_s/α_n) appears to follow roughly the expectation of the BCS theory for longitudinal waves. (auth)

6481 INVESTIGATION OF SUPERCONDUCTING PHASE TRANSITIONS IN Pb FILMS WITH ACOUSTIC SURFACE WAVES. Kraetzig, E.; Walther, K.; Schilz, W. (Philips Zentrallaboratorium GmbH Hamburg). Phys. Lett.; 30A: 411-2(1 Dec 1969).

Phase transitions of first and second order and critical magnetic fields for bulk and surface superconductivity in Pb films were investigated with ultrasonic surface waves. (auth)

6482 OSMOTIC PRESSURE WAVES IN SUPERFLUID ^{3}He–^{4}He MIXTURES. Ghozlan, A. C.; Varoquaux, E. J.-A. (Faculte des Sciences, Orsay, France). Phys. Lett.; 30A: 426-7(1 Dec 1969).

The second sound velocity of superfluid ^{3}He–^{4}He mixtures is connected by a simple thermodynamic formula to the osmotic pressure. Within the framework of the BBP theory, the experimental data for these two quantities are found to be nonconsistent. (auth)

6483 FLUX LINE LATTICES IN THE INTERMEDIATE STATE OF A Pb–In ALLOY. Wilcockson, A.; Sarma, N. V. (International Research and Development Co. Ltd., Newcastle upon Tyne, Eng.). Phys. Lett.; 30A: 435-6(1 Dec 1969).

Flux line lattices have been observed in the intermediate state structures of a Pb–1.7 at. % In alloy disc, at 4.2°K, using a refined Bitter pattern technique. (auth)

6484 CREEP-LIKE FLUX FLOW IN SUPERCONDUCTING NIOBIUM. Ullmaier, H. A. (Kernforschungsanlage, Juelich, Ger.). Solid State Commun.; 7: 1565-7(Nov 1969).

"Creep-like" flux changes observed during magnetization measurements on thick Nb samples are reported. It is shown that a simple flux flow model satisfactorily describes the observed time dependence. (auth) (UK)

6485 EFFECT OF TWIST ON ac LOSS AND STABILITY IN MULTISTRAND SUPERCONDUCTING COMPOSITES. Critchlow, R. R.; Zeitlin, B.; Gregory, E. (Air Reduction Co., Inc., Murray Hill, N. J.). Appl. Phys. Lett. 15: 225-7(Oct. 1, 1969).

The effect of twist on a variety of multistrand NbTi superconducting composites was studied. Twisting reduces the ac loss and increases the stability of the conductors. It is found that a critical twist rate exists beyond which little or no further improvement occurs. (auth)

6486 GENERATION OF HIGH-FREQUENCY OSCILLATIONS BY THIN SUPERCONDUCTING TIN FILMS. Churilov, G. E.; Dmitriev, V. M.; Beskorskii, A. P. (Physico-Technical Inst. of Low Temperatures, Kiev). JETP Lett. (USSR) (Engl. Transl.); 10: 146-7(5 Sep 1969).

Translated from Zh. Eksp. Teor. Fiz., Pisma Redaktsiyu; 10: 231-3(5 Sep 1969).

The results of experiments on observation of the generation of high-frequency oscillations by long thin superconducting films are described. Films of tin deposited on a glass substrate by the vacuum-sputtering method and leaving these dimensions (thickness 250 Å, width 0.15 mm, length 13 mm) were investigated. (M.H.R.)

6487 ABSORPTION OF ULTRASOUND BY TIN IN THE INTERMEDIATE STATE. Bezuglyi, P. A.; Denisenko, V. I.; Fil, V. D. (Physico-Technical Inst. of Low Temperatures, Kiev). JETP Lett. (USSR) (Engl. Transl.); 10: 134-6(5 Sep 1969).

Translated from Zh. Eksp. Teor. Fiz., Pisma Redaktsiyu; 10: 214-16(5 Sep 1969).

Results are reported of experiments on a cylindrical sample 6 mm in diameter and 12 mm long, with its axis close to the [110] direction and coinciding with the sound propagation direction. The initial material was tin with a resistance ratio R(300°K)/

$R(4.2°K) = (4 - 5) \times 10^{-4}$. The sample was placed in a transverse magnetic field produced by a solenoid. The measurements were made at frequencies 10, 30, 70, 110 MHz. (M.H.R.)

6488 PRESSURE-INDUCED MAGNETIC–NONMAGNETIC TRANSITION OF Ce IMPURITIES IN La. Maple, M. B.; Wittig, J.; Kim, K. S. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett.; 23: 1375-7(15 Dec 1969).

A transition of Ce impurities from a magnetic to a nonmagnetic state was observed in superconducting La–Ce alloys at high pressure. The critical pressure for maximum pair breaking in La–Ce alloys is lower for the fcc than for the dhcp phase. The highest transition temperature of an elemental superconductor (12°K) is reported for pure La at 140 kbar. (auth)

6489 A SIMPLE CRYOPUMPED CRYOSTAT FOR USE WITH A SUPERCONDUCTING MAGNET. Springford, M.; Stockton, K. R. (Univ. of Sussex, Brighton, Eng.). Cryogenics; 9: 390-1(Oct 1969).

In a recent note Finegold (Cryogenics 9: 135(1969)) drew attention to the usefulness of carbon dioxide for cryopumping the vacuum jackets of liquid nitrogen dewars. The authors have employed a few torr of carbon dioxide to cryopump combined vacuum spaces surrounding both the liquid helium and liquid nitrogen dewars of a large metal cryostat for a supreconducting magnet. The method used is outlined. (UK)

6490 LOW-FREQUENCY RESPONSE FUNCTION OF A SUPERCONDUCTOR AT FINITE TEMPERATURE. Bardasis, A. (Univ. of Maryland, College Park). Phys. Rev.; 186: 402-8 (10 Oct 1969).

The full temperature-dependent dielectric function is developed for the superconducting state. The specific case of low-temperature and low-frequency is solved within the Bardeen–Cooper–Schrieffer model potential for the imaginary part $\epsilon_2(q,\Omega)$. The result is found to give a term proportional to $\Omega^{\frac{1}{2}}$ for the contribution of the collective excitations, along with the usual Ω term due to quasiparticle excitations. Reference is made to recent work by Ferrell and Schmidt, in which consideration of fluctuations in the phase of the complex order parameter of the superconducting state requires that $\epsilon_2(q,\Omega)$ increase more rapidly than Ω^2 in order for the state to remain stable against these fluctuations. The discrepancy between this result and our work indicates the necessity for considering fluctuations in the magnitude of the order parameter as well as the phase, for a complete investigation of the effects of fluctuations. (auth)

6491 RELAXATION AND ELECTROMAGNETIC RESPONSE OF A SUPERCONDUCTOR IN A STATE OF SUPERCURRENT FLOW. Schmid, Albert (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev.; 186: 420-8(10 Oct 1969).

The situation is investigated in which a superconductor in a state of supercurrent flow and near the transition temperature is exposed to an alternating electric field. The induced alternating current is shown to exhibit a frequency dependence $(1 - i\Omega\tau_R)^{-1}$, which is due to a relaxation process in the Cooper-pair density. The relaxation time τ_R is determined by electron–photon collisions (collision time τ_c), in which case $\tau_R \simeq \tau_c[T_c/(T_c - T)]^{\frac{1}{2}}$; impurity scattering is important only under certain conditions, in which case $\tau_R \simeq 10^{-11}[T_c/(T_c - T)]^{-\frac{1}{2}}$ sec. (auth)

6492 ANGULAR MOMENTUM AND TRANSITION-METAL SUPERCONDUCTIVITY. Hopfield, J. J. (Princeton Univ., N. J.). Phys. Rev.; 186: 443-51(10 Oct 1969).

The relation between the systematics of superconductivity in the transition metals and the Periodic Table suggests that the transition temperature is chiefly a short-range or "chemical" property. When a local representation of phonons and an angular momentum decomposition of electron wave functions are used, the conventional description of electron–phonon interactions contains chiefly scatterings which change the angular momentum of the electron. This selection rule makes possible the writing of the electron–phonon coupling constant λ as the quotient of two parameters, each of which is of a chemical nature. This simplification is possible for materials having a high density of d states at the Fermi energy. For such materials, λ is little affected by the density of states. The theory is compared with the superconducting transition temperatures of transition metals and their alloys. (auth)

6493 SELECTION RULE FOR TUNNELING FROM SUPERCONDUCTORS. Dowman, J. E.; MacVicar, M. L. A.; Waldram, J. R. (Royal Society Mond Lab., Cambridge, Eng.). Phys. Rev.; 186: 452-5(10 Oct 1969).

The selection rules imposed upon tunneling electrons by different sorts of barriers are discussed, using wave-matching arguments. It is shown that the commonly used velocity selection rule is not generally valid. This reopens the question of interpreting the energy-gap data obtained from tunneling for anisotropic superconductors. (auth)

6494 POSSIBLE PAIRING WITHOUT SUPERCONDUCTIVITY AT LOW CARRIER CONCENTRATIONS IN BULK AND THIN-FILM SUPERCONDUCTING SEMICONDUCTORS. Eagles, D. M. (National Aeronautics and Space Administration Electronics Research Center, Cambridge, Mass.). Phys. Rev.; 186: 456-63 (10 Oct 1969).

Simultaneous equations for the BCS parameter Δ and for the Fermi energy in the BCS state are studied at low carrier concentrations in bulk and thin-film superconducting semiconductors at $T = 0$ for large cutoff energies, and solutions are plotted in the form of universal curves. For electron–electron attraction greater than some critical value in bulk material or for any attractive interaction in very thin films, the pair-binding energy tends to a constant limit for low n, and pairing without superconductivity is expected in some temperature range. Solutions of simultaneous equations for T_c as obtained by formal application of the BCS theory, and for the Fermi energy at T_c, are also obtained in bulk material; but it is shown that at low carrier concentrations the temperature T_p at which pairing takes place is given by $T_p = 2T_c$, while it is thought that superconductivity will not set in until a lower temperature, of the order of the Bose–Einstein condensation temperature of the pairs, is reached. By combining the above theory with a previously published model for superconductivity in Zr-doped $SrTiO_3$, predictions for this material in the region of low carrier concentrations are made. (auth)

6495 TUNNELING INVESTIGATION OF ENERGY-GAP ANISOTROPY IN SUPERCONDUCTING BULK Pb. Blackford, B. L.; March, R. H. (Dalhousie Univ., Halifax, Nova Scotia). Phys. Rev.; 186: 397-9(10 Oct 1969).

A technique has been developed for tunneling from thin Pb films into Pb single crystals formed by a high-vacuum melting process. A preliminary investigation of the energy-gap anisotropy has been carried out. Data are presented from ten separate junctions, including ones on the (001) and (111) crystal facets. In all cases, two energy gaps, Δ_1 and Δ_2 ($\Delta_1 < \Delta_2$), were apparent in the characteristics and differed from each other by 10 to 15%. The maximum variation of Δ_1 was 5% over the tunneling directions studied, while Δ_2 varied by considerably less than this. The maximum observed value of $2\Delta_2(0)$ was 2.78 ± 0.01 MeV and the minimum value of $2\Delta_1(0)$ was 2.36 ± 0.01 MeV. A comparison was made with a published theory of the energy-gap anisotropy. In some respects the agreement is fairly good, while in other respects it is poor. No evidence was found for the predicted structure due to critical points of the energy-gap surface in k space. Second-derivative measurements (d^2V/dI^2 versus V) showed an extra (compared to results from thin-film Pb junctions) peak in the group of structures associated with the transverse phonon modes. (auth)

6496 TEMPERATURE DEPENDENCE OF THE SUPERFLUID HEALING LENGTH. Henkel, R. P.; Smith, E. N.; Reppy, J. D. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 23: 1276-9(1 Dec 1969).

The reduction in superfluid mass of helium contained in restricted geometries has been studied as a function of temperature. The results are discussed in terms of a superfluid healing length ξ_S. Near T_λ, ξ_S can be described by a power law, $\xi_S = \xi_{S,0}(1 - T/T_\lambda)^{-\nu}$, where $\nu = 0.67 \pm 0.04$. A value for $\xi_{S,0} = 4.0 \pm 0.5$ Å is obtained from the analysis of superfluid flow through a slit of known geometry. (auth)

6497 SOUND ABSORPTION IN LIQUID HELIUM BELOW 0.6 K. Wehner, R. K.; Klein, R. (RCA Ltd., Zurich). Phys. Rev. Lett.; 23: 1372-4(15 Dec 1969).

The temperature dependence of ultrasonic attenuation in superfluid ^{4}He below 0.6 K is studied. It is shown that vertex corrections in the phonon self-energy improve the agreement with experiment, especially near the transition between the collisionless and collision-dominated regions. The introduction of one average lifetime for the relevant thermal phonons is critically examined. (auth)

6498 ON POINT DEFECTS IN THE FLUXON LATTICE: SOME ATOMIC CALCULATIONS. Hill, D. C.; Morrison, D. D.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). Solid State Commun., 7: 1179-80(Sept. 1969).

The stability and configurations of vacancies and interstitials in the flux line lattice characterizing the mixed state of type II superconductors were examined by a self-consistent variational calculation by computer. The calculations confirmed the known experimental observations, but also showed that pinning forces directly determine which configuration is more stable. (auth) (UK)

6499 THICKNESS DEPENDENCE OF THE CRITICAL TEMPERATURE OF THE SUPERCONDUCTING TRANSITION OF COLD-DEPOSITED BERYLLIUM FILMS. Alekseevskii, N. E.; Tsebro, V. I. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.), 10: 114-17(Aug. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 10: 181-4(Aug. 20, 1969).

The critical temperatures of cold-deposited beryllium films were measured in the range 25 to 1000 Å. At thicknesses exceeding ~200 Å, the films did not become superconducting down to 1.3°K. Thinner films revealed an approximately exponential growth of the critical temperature with increasing thickness. The maximum critical temperature, 8.2°K, was observed for films ~60 Å thick. With further decrease of the thickness, a drop of T_c was observed, and for a film ~25 Å thick the value of T_c was 6.4°K. (M.H.R.)

6500 NOISE IN A DRIVEN JOSEPHSON OSCILLATOR. Stephen, Michael J. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev.; 186: 393-7(10 Oct 1969).

The effect of noise on the microwave-induced steps in the current–voltage characteristic of a Josephson junction is investigated theoretically. The dynamic resistance of a step is obtained in the limit that the capacitance of the junction is small. The phase fluctuations of the junction are greatly reduced in the presence of the microwave signal, and the dynamic resistance can be extremely small. (auth)

6501 MAGNETIC FIELD EFFECTS IN THE ONSET OF SUPERCONDUCTIVITY. Mikeska, Hans-Juergen; Schmidt, Hartwig (Institut Max von Laue, Garching, Ger.). Z. Phys.; 230: 239-54(1970).

Using the time-dependent Ginzburg–Landau theory, the influence of a finite and even strong magnetic field on the fluctuations in superconductors above T_c is studied. The dynamical conductivity, the Hall angle, and the static magnetization are calculated from the fluctuations of the charge current associated with the fluctuations of the order parameter. It is found that the magnetic field generally enhances the singular contributions of the fluctuations to the conductivity and the susceptibility. Associated with this enhancement is a reduction of the characteristic frequency scale close to T_c. (auth)

6502 THERMAL WAVE PROPAGATION IN HELIUM II. Schlueter, Roger Selig. Pasadena, Calif.; California Inst. of Tech. (1969). 127p.

Thesis.

Landau's equations for the two-fluid model of liquid helium II are used as the basis for an investigation of the properties of thermal wave propagation. A number of assumptions are made which reduce the four original equations to a system of two nonlinear partial differential equations valid to first order in the relative velocity of the two components. These equations are analogous to Riemann's equations which describe pressure waves in a classical fluid. This system of equations, when reduced to just one space dimension is shown to be hyperbolic and a set of characteristics and invariants is found. A particularly simple, one-dimensional problem is then formulated and an explicit solution is given. This solution is then studied in detail to show the distortion of a temperature pulse as it propagates and also to show effects such as nonlinear breaking. Subsequently, the restrictive assumptions are eliminated individually and the equations are then valid to second order in the relative velocity; the effects of including thermal expansion and using the relative velocity as a thermodynamic variable are given. Also, some effects due to the interaction of first and second sound are investigated. In all cases, the results are compared with other results based on equations differing from the Landau equations and with results found by using perturbation techniques. Finally, equations based on the same Landau equations that describe steady-state shock (discontinuous) solutions are derived and discussed. Suggestions for further theoretical and experimental work are made. (Disser. Abstr. Int., B)

6503 INTERMEDIATE STATES IN THIN SUPERCONDUCTORS. Brandt, Bruce Losure. Rochester, N. Y.; Univ. of Rochester (1969). 139p.

Thesis.

The state of a thin type-I superconductor in a magnetic field was examined to determine its dependence on the specimen thickness and on the value of the Ginzburg–Landau parameter for the specimen. Three materials (aluminum, indium, and $In_{98}Pb_{91}$) with values of the Ginzburg–Landau parameter ranging from 0.04 to 0.29 were studied. Specimen thicknesses ranged from 200 to 200,000 Å. The perpendicular critical field as a function of the thickness of the specimen and of the Ginzburg–Landau parameter were measured. All of the materials studied were type-I or nonlocal superconductors in the bulk. Yet, it had been predicted that they would behave in ways characteristic of type-II or local superconductors if the specimens were sufficiently thin. For intermediate thicknesses the specimens were expected to be in one of many possible states. It was shown that the structure of the intermediate state in thin films of type-I superconductors is equivalent to the type-II vortex state for very thin films ($d < < \xi_0$), and to the type I macroscopic domain state for very thick films [$d > 2\xi$ (t)]. For thicknesses between these limits, the intermediate-state structure takes on many forms as the area of each normal domain and the amount of flux threading it increases with increasing thickness. In the limit $K \to 0$, the increase in the area of each domain is limited by the high energy associated with the normal/superconducting interface. (TSS) (Disser. Abstr. Int., B)

6504 THERMAL CONDUCTIVITY MEASUREMENTS OF GAPLESS BEHAVIOR INDUCED BY THE PROXIMITY EFFECT. McConnell, Robert Dean. New Brunswick, N. J.; Rutgers–The State Univ. (1969). 125p.

Thesis.

The thermal conductivities K_s and K_n in the superconducting and normal states were measured for six In–Bi films in contact with Mn layers. K_s/K_n was found to be a linear function of temperature in the gapless region near the critical temperature as expected from the theory of gapless superconductivity. This behavior contrasts with that of a BCS superconductor having an energy gap since K_s/K_n then approaches the critical temperature with zero slope. Measurements as a function of temperature indicate that there are states near the boundaries which remain available at temperatures far below those at which the entire sample is gapless. The existence of localized low-energy states is also used to explain recent tunneling results which otherwise appear to be contradictory. The thermal conductivity of the thickest sample was also measured as a function of magnetic field. The results near H_{c2} are compared with the theory of gapless superconductivity and show reasonable agreement once demagnetization effects are included. (Disser. Abstr. Int., B)

Plasma and Thermonuclear Physics

6505 PLASMA PHYSICS: TECHNOLOGY INDEX. VOLUME 3, No. 10, 1969. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 76p.

163 articles on various aspects of plasma physics are listed. (M.O.W.)

6506 PLASMA PHYSICS INDEX. VOLUME 4, No. 9, 1969. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 211p.

425 articles on various aspects of plasma physics are listed. (M.O.W.)

Confinement and Heating

6507 (AD-693807) HEATING AND ENHANCED DIFFUSION DURING A BEAM–PLASMA INSTABILITY. Bohmer, H.; Raether, M. (Illinois Univ., Urbana. Coordinated Science Lab.). Sep 1969. Contract DAAB07-67-C-0199. 30p. (R-429). CFSTI.

An enhanced plasma diffusion is observed during the interaction of an electron beam of 0.1- to 1.0-A current with a weakly ionized Ne-afterglow plasma. The parameter dependence of this effect is investigated in the electron density region 10^{10} to 10^{13} cm^{-3} and the pressure range 0.01 to 0.1 torr. Evidence is presented that this diffusion is due to heating of the plasma electrons partly by collisional damping of unstable plasma waves and partly by thermalization of secondary electrons emitted in ionizing collisions between beam electrons and neutral neon atoms. (auth) (USGRDR)

6508 (MATT-717) CONVECTIVE AND OSCILLATORY LOSSES IN Q-MACHINES. Chen, Francis F. (Princeton Univ., N. J. Plasma Physics Lab.). Oct 1969. Contract AT(30-1)-1238. 15p. (CONF-690923-3). Dep. CFSTI.

From International Conference on Physics of Quiescent Plasmas, Paris, France.

Anomalous transport in Q machines is caused partially by dc convection and partially by oscillations. Pure drift waves can account for only a small radial loss because their amplitude is small at the boundary. Large nonlinear oscillations can cause a large loss by increasing the dc convection. Turbulent fluctuations can carry plasma across the boundary easily and also cause a large loss when the spectrum extends to low frequencies (not necessarily dc). An effort was made to confirm these conclusions

by direct measurements of the radial flux by means of a plasma-eater, but the data did not give self-consistent results. (auth)

6509 (NP-18059) PLASMA HEATING WITH STRONG ELECTRON BEAMS IN A MIRROR-TYPE MAGNETIC TRAP. Demirkhanov, R. A.; Gevorkov, A. K.; Popov, A. F.; Pokhanka, Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 1969. 43p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The effect of beam instability on the mechanism of plasma heating in a mirror-type magnetic trap was studied. The experiments were performed with plasma produced by the beam and with plasma injected into the trap from an external source. The dynamics of the instability development and plasma heating processes were analyzed in detail. Theoretical results and experimental data showed that the process of plasma heating under instability conditions was followed by an abnormally fast escape of charged particles from the trap. (tr-auth)

6510 (NP-tr-1861) EXPERIMENTS WITH STRONG SHOCK-WAVES ON "VODA I." Kapitonov, V. A.; Kornilov, V. A.; Lagunov, V. M.; Nesterikhin, Yu. E.; Papyrin, A. N.; Ponomarenko, A. G.; Federov, V. M. (Akademiya Nauk SSSR, Novosibirsk. [Institut Yadernoi Fiziki]). Translated for Culham Lab., Abingdon, Eng., from Preprint No. 238. 11p. (CTO-658). Dep. CFSTI (U. S. Sales Only).

Experiments are described on the excitation of strong collisionless shock waves ($M \gtrsim 5$) with subsequent containment of the plasma by the magnetic field of the shock loop. A magnetic piston of ~ 20 kOe was produced within $\sim 100 \times 10^{-9}$ sec by a current generator forming a long line with water insulation for 250 keV and wave impedance of 1Ω. (auth)

6511 (NP-tr-1862) SOME ASPECTS OF HEATING A PLASMA BY A STRAIGHT DISCHARGE CURRENT. Koydan, V. S.; Papyrin, A. N.; Ponomarenko, A. G.; Yablochnikov, B. Ya. (Akademiya Nauk SSSR, Novosibirsk. [Institut Yadernoi Fiziki]). Translated for Culham Lab., Abingdon, Eng., from Preprint No. 241. 10p. (CTO-655). Dep. CFSTI (U. S. Sales Only).

New experimental results on the turbulent heating of plasma by the current of a straight discharge are reported. It is shown that for different current shapes the potential drop in the plasma column is concentrated in a region of ~5 cm and may move along the discharge gap. The maximum anomalous resistivity and gap voltage coincide with the instant of the abrupt drop of the current, and this moment coincides with the return electron current to the cathode. The onset of turbulence is characterized by a spreading of the plasma column to the chamber walls. Possible causes of the observed effects are suggested. (auth)

6512 REPELLING OF PLASMA WITH LOCAL ELECTRON CYCLOTRON RESONANCE. Abe, H.; Sugawa, M.; Terumichi, Y.; Tanaka, S. (Kyoto Univ.). Phys. Lett.; 30A: 394-5(1 Dec 1969).

Experimental results are presented for repelling and trapping of a plasma beam in a mirror field by the local electron cyclotron resonance with the nonuniform static magnetic and electromagnetic fields. (auth)

6513 OPTIMAL CONTROL OF A CLASS OF LINEAR SYMMETRIC HYPERBOLIC SYSTEMS WITH APPLICATIONS TO PLASMA CONFINEMENT. Wang, P. K. C. (Univ. of California, Los Angeles). J. Math. Anal. Appl.; 28: 594-608(Dec 1969).

Problems involving the optimal control of systems of hyperbolic partial differential equations have been studied recently. This paper considers certain optimal control problems associated with a class of symmetric hyperbolic linear partial differential equations arising from the confinement of hot plasmas by means of external electromagnetic fields. Attention is focused primarily on the derivation of necessary conditions which an optimal control must satisfy. Physical interpretations of these conditions for certain plasma confinement problems are given. (auth)

6514 HEATING IN LOW DENSITY θ-PINCH PLASMA. Shiina, Shoichi; Ohnishi Haruyuki (Nihon Univ., Tokyo). Kakuyugo Kenkyu; 23: 367-81(Oct. 1969). (In Japanese).

The heating of θ-pinch plasma produced by 18-KJ fast condenser bank was investigated at an early stage in the increasing magnetic field. The electron temperature was determined from the absorption method of soft x rays at initial pressures of 10 to 200 mtorr D_2. The time histories of neutron, visible light, and hard x ray emissions were also observed. The soft x-ray measurements showed the higher (several keV) and the lower ($\sim 10^2$ eV) electron temperatures. The higher electron temperature can be observed under the condition that the plasma density is within the extremely low region. The neutron detector showed the more intense signal in the plasma with the higher electron temperature than in the lower electron temperature, in spite of the lower density. The production of such higher-temperature plasma can be considered as a dissipative phenomenon in the collisionless plasma, which may result from a microinstability, for instance, the electron–ion two-streaming instability of the θ-pinch configuration. (NSA of Japan)

6515 PLASMA HEATING BY A CHARGED-PARTICLE PULSE. Yadavalli, S. V. (Stanford Research Inst., Menlo Park, Calif.). Int. J. Electron.; 27: 147-54(Aug 1969).

The energy transferred to a plasma, due to induced currents in the plasma caused by the passage of a charged-particle pulse through an assumed uniform and homogeneous plasma of finite lateral extent, is evaluated. Two different models of pulse current distributions are treated. Numerical results pertinent to a typical example are presented. Comments are also made regarding the self-magnetic field of the pulse. (auth) (UK)

6516 SOME CONSIDERATIONS ON THE ELECTROSTATIC CONFINEMENT OF FUSION GASES. Porter, Gary Dean. University Park, Pa.; Pennsylvania State Univ. (1968). 140p. Thesis.

Three analytical problems of interest in inertial electrostatic confinement are investigated; (1) steady-state solutions, collisionless theory, (2) effect of collisions, and (3) stability during startup. The steady-state solutions are derived in both plane and spherical geometry by solving the Vlasov equation for ions emitted from an anode which is outside a negatively biased, electron-emitting cathode. The use of the Vlasov equation permits the investigation of the effect of the angular dependence of the electron source. It was found that this effect is negligible outside the virtual cathode. The analysis is then restricted to this region so that it can be assumed all particles are introduced in monoenergetic radial beams. It is found that there is a significant decrease in the ion current across the virtual anode. This is a result which is not in agreement with experiment, and it indicates a need for a theory which includes a mechanism for ion trapping. Binary collisions provide one mechanism for trapping particles in potential wells. Because of the long mean free path indicated by experiment, a test particle approach is adopted to study collisional effects. The interaction of the "test particles" with a steady-state plasma in the fusor is investigated. The distribution of test particles is expanded into a sum. The first term represents those test particles which undergo no collisions; the second term, which is presumed smaller, represents those which have collided once, etc. A general formalism is developed to solve for the n^{th} term. The general formulas do not require any specific steady state solution for the plasma in the fusor. To obtain explicit results, the steady state, collisionless solutions found previously are used. The solution for the test particles which have undergone one collision is presented in a form which can be computed numerically. Numerical calculations are not performed, however, because serious doubt has developed as to the validity of the use of the steady state, collisionless solutions for the plasma in the fusor. The nature of electron instabilities in an inhomogeneous, spherical plasma is studied. It is assumed that the ions are injected first, reach an equilibrium, then remain fixed. The electrons are then introduced and establish a virtual cathode. The electrons coming from the virtual cathode interact with those going from the cathode toward the virtual cathode. The possibility of a two-stream instability is therefore present. The linear stability of this asymptotic steady state — ions fixed, electrons moving in radial beams — is analyzed. It is found that this state is marginally stable. It is speculated that the lowest order ion response is needed to find instability. The formalism for the latter calculations is set up, but the numerical computations are not performed. (Disser. Abstr. Int., B)

Diagnostics

6517 (AD-694063) SPECTROSCOPIC DETERMINATION OF ELECTRON AND ION TEMPERATURES IN STEADY-STATE HELIUM AND ARGON PLASMAS. Leonard, Stanley L. (Aerospace Corp., El Segundo, Calif.). 30 Sep 1969. Contract F04701-69-C-0066. 32p. (TR-66(9220-02)-2; SAMSO-TR-69-296). CFSTI.

Spectroscopic measurements of electron and ion temperatures in steady-state helium and argon plasmas are reported. Electron temperatures were determined on the basis of coronal equilibrium from measured ratios of the intensities of spectral lines emitted by ions in different stages of ionization. Measurement of the doppler-broadened widths of spectral lines by means of a pressure-swept Fabry–Perot interferometer were used to obtain ion temperature values. Evidence is presented to indicate that the population of excited states of neutral helium are governed by an influx of background neutral particles. It is also shown that excited-state populations of singly ionized argon obey coronal equilibrium. (auth) (USGRDR)

6518 DETERMINATION OF FLOWING GAS PARAMETERS, BASED ON THE EXPERIMENTS WITH ARGON PLASMA STREAM PRODUCED BY A STRETCHED ARC. Neumann, W. Pr. Inst. Masz. Przeply.; No. 34, 69-86(1967). (In German).

Conventional diagnostic methods suitable for measurements in plasma jets are reviewed. Several methods for the measurement of electron temperature, electron density, gas temperature, plasma composition, and mass velocity are sketched, with references to relevant research papers. A method for measuring the mass velocity in an atmospheric argon plasma jet by using small silicon carbide particles is discussed in more detail. This method was used by the author in conjunction with former energy flow measurements in plasma jets. (App. Mech. Rev.)

6519 PLASMA PARAMETER SLIDE RULE. Nordlund, D. R. (Systems Research Labs., Dayton, Ohio); Breaux, O. P. Rev. Sci. Instrum.; 40: 1618-22(Dec 1969).

A slide rule was developed to facilitate rapid calculation of basic plasma parameters such as electron number density, Debye length, and the number of particles in a Debye sphere. These parameters can be readily calculated within an accuracy of 1.5% for most practical situations involving the application of plasma probes. In addition the slide rule can be used to determine whether Coulomb collisions preclude application of collisionless probe theory in plasma diagnostics. (auth)

6520 NARROW BAND FAR INFRARED INTERFEROMETER FOR ELECTRON DENSITY MEASUREMENTS. Andrews, Merrill L.; Brown, Sanborn C. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-3980. Rev. Sci. Instrum.; 40: 1626-30(Dec 1969).

An interferometer was constructed with reflection optics and lamellar gratings to operate in the wavelength range of 175 to 400 μ. The gratings serve not only as beam splitters and recombiners but also as filters to separate out a narrow band of radiation. In this way a simple wide-band Hg arc lamp can be used as the source. Because of the required response time for afterglow plasmas, a Putley detector measures the radiation. An application of the interferometer was to measure electron densities in repetitively pulsed plasma with $\lambda = 200\ \mu$ and a time response of 3 μsec. The electron line density sensitivity is 3×10^{13} cm^{-2}, and line densities were measured up to 10^{15} cm^{-2}, still substantially below the instrumental limit. (auth)

6521 MICROWAVE DIAGNOSTICS OF A TRANSIENT PLASMA WITH AN ACTIVE FABRY–PEROT RESONATOR. Ajmera, R. C.; Lashinsky, H. (Univ. of Maryland, College Park). J. Appl. Phys.; 40: 4869-71(Nov 1969).

A technique is described for microwave diagnostics of a transient plasma that makes use of an active Fabry–Perot resonator, in which a positive-feedback loop is to provide gain. Experimental results indicate that the technique is attractive from the point of view of sensitivity, dynamic range, time resolution and convenience of readout. (auth)

6522 MICROWAVE NONLINEAR PROPERTIES OF THE LANGMUIR PROBE. Weiner, Maurice; True, Robert M. (Army Electronics Command, Fort Monmouth, N. J.). J. Appl. Phys.; 40: 4872-7(Nov 1969).

Microwave nonlinear effects have been observed in the plasma sheath surrounding a probe. Results were obtained for a PIG discharge operating at 2.0×10^{-2} torr xenon. The nonlinear effects include mixing, harmonic generation, and current rectification. The probe is connected directly to a 50-Ω coaxial transmission line through which the microwave signal is coupled to the sheath. Strong nonlinear interaction is observed when the probe is dc biased at a point in the exponential region of the Langmuir curve. The explanation of this interaction is based on the usual interpretation of the sheath as a nonlinear capacitance. (auth)

6523 SIMPLE CIRCUIT FOR OBTAINING THE ELECTRON ENERGY DISTRIBUTION IN A PLASMA. Alexeff, E.; Howell, D. F. (Univ. of Tennessee, Knoxville, Oak Ridge National Lab., Tenn.). J. Appl. Phys.; 40: 4877-82(Nov 1969).

A very simple technique is described for obtaining an instantaneous display of the electron energy distribution in a plasma. The current–voltage characteristic of the Langmuir probe is doubly differentiated following the method of Druyvesteyn. Operational amplifiers were used for differentiation. The new contributions are: first, discovery of where the noise is produced that formerly made operational amplifiers unsatisfactory; second, demonstration that this noise can be eliminated; and third, development of simple techniques for cross checking the double-differentiating system to demonstrate that the noise-elimination process does not appreciably distort the desired information.(auth)

6524 MEASUREMENT OF THE ELECTRON TEMPERATURE BY THOMSON SCATTERING IN TOKAMAK T.3. Peacock, N. J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.); Robinson, D. C.; Forrest, M. J.; Wilcock, P. D.; Samnikov, V. V. Nature (London); 224: 488-90(1 Nov 1969).

Measurements of the electron temperature and density of the plasma in the toroidal discharge apparatus Tokamak T.3 at the Kurchatov Inst. are described, using Thomson scattering by the plasma electrons of 6943 Å light from a Q-spoiled ruby laser. Electron temperatures of 100 eV up to 1 keV and densities in the range 1 to 3×10^{13} cm^{-3} were measured, and the results agreed with those obtained by other techniques where direct comparison was possible. (UK)

6525 DETERMINATION OF THE PARAMETERS OF A DENSE PLASMA ON THE BASIS OF THE DISPLACEMENT AND THE HALF-WIDTH OF SATELLITES IN THE SCATTERED LIGHT SPECTRUM. Pyatnitskii, L. N.; Khaustovich, G. P.; Korobkin, Vl. V. (Inst. of Energetics, Moscow). Dokl. Akad. Nauk SSSR; 188: 73-6(1 Sep 1969). (In Russian).

The parameters of a plasma may be determined on the basis of the scattering of laser emission by electrons. The spectral intensity of the scattered light throughout the whole frequency range, except the frequency corresponding to the location of the satellites, is of the order of magnitude of the plasma noise; therefore, in the presence of satellites, it is not possible to determine the plasma parameters from the total intensity of the scattered light. Under special conditions these parameters may be obtained from the shift of the satellites and their half-width. The scattering spectra were obtained by means of an argon arc plasma at atmospheric pressure with tungsten and carbon electrodes. From the experimental data it was calculated that the concentration n_e and the temperature T_e of the electrons are $n_e = 9.0 \times 10^{15}$ cm^{-3} and $T_e \lesssim 10{,}000$°K. (TTT)

6526 MEASUREMENTS OF EXCITATION TEMPERATURE IN AN ARGON PLASMA JET. Rienzi, S. A.; Gaydon, A. G. (Imperial Coll. of Science and Technology, London). High Temp.-High Pressures; 1: 231-6(1969).

The temperature distribution, both radial and axial, was investigated using relative intensities of the blue group of argon lines. The Abel inversion method was employed. Values of transition probabilities from various authors are compared; those by Coates and Gaydon were used, but those of Gericke and of Malone and Corcoran are also satisfactory. Calorimetric measurements on the jet enabled a mean gas temperature to be calculated. This was only slightly below the maximum measured value, and supports the view that local thermodynamic equilibrium is attained on the axis of the jet. Wall cooling and air entrainment are important. The possibility of effects due to radiation depletion is discussed. (auth) (UK)

6527 THE APPLICATION OF THE PULSED IONIZATION CHAMBER TECHNIQUE FOR ^{3}He PLASMA PARAMETER MEASUREMENTS AND KINETIC STUDIES. Ellis, W. H. (Univ. of Florida, Gainesville); Cofer, H. G. Trans. Amer. Nucl. Soc., 12: 516-17(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6528 RESPONSE OF FREE-MOLECULE CYLINDRICAL LANGMUIR PROBES IN A TURBULENT PLASMA. Peterson, Edward William. Berkeley, Calif.; Univ. of California (1968). 144p.

Thesis.

A theoretical and experimental investigation of the response of a free-molecule Langmuir probe in a turbulent plasma is made. The effect of arbitrary fluctuations in charged-particle density, electron temperature, plasma potential, and ion temperature are considered. The results are applicable for a) frequencies somewhat less than the ion plasma frequency, b) moderate ratios of probe radius to Debye length, c) moderate ratios of applied potential to electron temperature and d) ratios of ion to electron temperatures less than one. The steady-state characteristic is obtained by forming an empirical fit to a numerical analysis describing the collisionless probe current collection. Relations are then derived showing the effect of fluctuations on the average properties, and the connection between the r.m.s. probe current and the various correlations. Electron temperature, charged-particle density, floating potential, single-probe saturation ion and electron current and double-probe current measurements are studied in detail. It is found that the sensitivity of the probe to the various fluctuating quantities is a function of the ratios of probe radius to Debye length, applied potential to electron temperature, and ion to electron temperature. Subsequently, it is shown that many of the correlations and average properties may be determined. Experiments

are performed in an unsteady highly expanded low-density flowing argon plasma. Both the average and r.m.s. currents are monitored using cylindrical Langmuir probes. In particular, the dependence of the intensity of the current fluctuations on the ratios of probe radius to Debye length and applied potential electron temperature are illustrated for saturation electron, saturation ion, and double-probe current collection. Pertinent features of the theory are verified and quantitative measurements of the fluctuating intensities and mean flow quantities are made. (Disser. Abstr.)

Kinetics (General)

6529 EXPANSION AND THERMALIZATION PROCESSES OF PLASMA FLOW ON THE BSG-II DEVICE. Uchida, T.; Miyamoto, K.; Fujita, J.; Leloup, C.; Kawasaki, S.; Inoue, N.; Suzuki, Y.; Adati, K. (Nagoya Univ., Japan). Nucl. Fusion, 9: 259-65(Oct, 1969).

The expansion process of a collision-dominated theta-pinch plasma in a homogeneous magnetic channel and the thermalization process of the kinetic energy of this plasma flow by a magnetic mirror field were observed by several methods of measurement. Four experimental results are presented: (1) the expansion of plasma along the homogeneous magnetic channel is adiabatic; it is well described by a model for one-dimensional isentropic flow of collision-dominated plasma; (2) the flow is supersonic and the occurrence of a shock in front of the mirror field is in accordance with a criterion concerning the supersonic–sonic transition of plasma flow; (3) the rate of plasma loss through the mirror field is reduced by the occurrence of the shock; (4) the values of the plasma parameters measured before and behind the shock front satisfy the Rankine–Hugoniot relations, though plasma pressure, flow velocity, and Mach number are time-dependent. (auth)

Kinetics (Experimental)

6530 (AD-694106) PLASMA FRONT STUDIES. Final Report. Barach, John Paul (Vanderbilt Univ., Nashville, Tenn. Dept. of Physics). 18 Sep 1969. 9p. (AFOSR-69-2320-TR). CFSTI.

Shock flow studies explaining the absence of separated shock flow by Taylor instability are mentioned. Also summarized are flux transport and arc spectroscopy experiments. In the latter, 4-eV plasmas are produced. New experiments with magnetically boosted shock tubes, with shocks in current-carrying plasmas and with high-field theta-pinch devices, are mentioned. (auth) (USGRDR)

6531 (BMwF-FBK-69-28) EXPERIMENTAL INVESTIGATION OF THE CONTINUOUS EMISSION OF SHOCK HEATED ARGON. Roders, H. (Technische Hochschule, Hanover (West Germany). Institut fuer Plasmaphysik). Oct 1969. 69p. (In German). Dep. CFSTI (U. S. Sales Only).

For the production of argon plasma, a diaphragm shock tube was developed in which the driver gas is heated by a powerful electrical discharge. Using this technique, it was possible to measure the continuum radiation behind the incident shock wave photographically. The emission coefficient and the ξ factor of argon I were determined in the wavelength region between 4000 and 6000 Å. The results are compared with measurements and theoretical calculations of other authors. (auth)

6532 (SGAE-PH-87/1969) IONIZATION AND DISSOCIATION OF YTTERBIUM CHLORIDE IN THE LOW VOLTAGE LOW PRESSURE ARC DISCHARGE. Wotke, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). [1969]. 5p. (CONF-690803-33). Dep. CFSTI (U. S. Sales Only).

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The dependence of the formation of Yb^+, Yb^{++}, Yb^{+++}, $YbCl^+$, $YbCl_2^+$, $YbCl_3^+$ and $YbCl^{++}$ ions in the arc discharge of the ion source of an electromagnetic isotope separator on the arc voltage is investigated. The results are discussed by taking into consideration the various modes of formation and dissociation. (auth)

6533 STARK BROADENING OF TWO IONIZED-HELIUM LINES BY COLLECTIVE ELECTRIC FIELDS IN A LABORATORY PLASMA. Griem, Hans R.; Kunze, H.-J. (Univ. of Maryland, College Park). Phys. Rev. Lett.; 23: 1279-81(1 Dec 1969).

Profiles of the He II 4686- and 3203-Å lines observed during the passage of the imploding current sheath in a high-velocity, low-density θ pinch show a broadening that at early times is not due to the usual mechanisms (Doppler, Holtsmark, Zeeman effects). Most of this broadening is therefore interpreted as due to Stark effects caused by suprathermal collective field fluctuations, and at later times as due to a combination of these and Doppler effects. (auth)

6534 MEASUREMENT OF THE EMISSION COEFFICIENT OF A URANIUM PLASMA. Schneider, R. T.; Randol III, A. G.; Kylstra, C. D.; Ohanian, M. J. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 12: 413-14(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6535 RADIATION FROM CURRENT SOURCE IMMERSED IN AXIALLY MAGNETIZED PLASMA COLUMN. Yip, Gar Lam. Toronto; Univ. of Toronto (1967).

Thesis.

The radiation characteristics of a current source, situated on the axis of an infinitely long and axially magnetized column of homogeneous, lossless and cold plasma, are investigated. The current source will excite space waves as well as surface waves. The radiated power and the radiation resistance, resulting from the space waves, are investigated as a function of the column radius, the signal frequency and the strength of magnetization. The presence of a suitable magnetostatic field results in a significant improvement in the transmission through the plasma column. For thin columns, strong radiation due to dipolar space waves occur at signal frequencies corresponding to the dipolar resonances, when the dipole is oriented perpendicular to the column axis. The surface waves are all slow waves guided along the plasma column, and exist only below the upper hybrid resonant frequency. In the gyro and the plasma resonance regions, the existence of an infinite number of discrete modes is noted. The dispersion curves are presented for different values of the strength of the applied magnetic field and the column radius. The power transported by a few of the lower-order symmetric surface-wave modes, excited by a point electric dipole, is evaluated and is found to approach infinity at the gyro and plasma frequencies. For a source with finite dimensions such as a filament with a triangular current distribution, however, the surface-wave power remains finite. (Disser. Abstr.)

6536 IONIZATIONAL NONEQUILIBRIUM IN EXPANDING PLASMA FLOWS. Morse, Frederick Henry. Stanford, Calif.; Stanford Univ. (1969). 176p.

Thesis.

A theoretical and experimental examination was made of the axial electron density profile in the rapid expansion of a weakly ionized, seeded argon plasma. Theoretical electron density profiles were obtained by solving the electron conservation equation with an ionization–recombination rate equation based on three-body recombination. The solution indicates that the electron density profile tends to level off, or freeze, resulting in a profile between that corresponding to equilibrium at the stagnation temperature and that corresponding to equilibrium at the considerably lower local gas temperature. Measurements of the electron density ($\sim 10^{12}$ cm^{-3}) both upstream and downstream of a supersonic nozzle were made using an X-band swept-signal microwave interferometer. The use of a swept-frequency interferometer made it feasible to use the ceramic flow channel walls as microwave windows and to locate and operate at those special frequencies where the channel walls had negligible effect. The swept-frequency method developed for these tests provided data via two techniques: interferometry and attenuation at two frequencies. The measured electron density downstream of the nozzle exit was significantly above the local Saha equilibrium value and in good agreement with the predicted values. The results indicate that there is no faster recombination process than three-body recombination acting over the range of conditions covered in these tests. (Disser. Abstr.)

Kinetics (Theoretical)

6537 (SC-RR-69-758) RADIATIVE ENERGY LOSSES FROM A HYDROGEN PLASMA WITH IMPURITIES. Olman, M. D. (Sandia Labs., Albuquerque, N. Mex.). Oct 1969. 22p. Dep. CFSTI.

The development of large magnetohydrodynamic codes requires the inclusion of the effects of radiative energy losses, including the possible effects of impurities. A computer routine was written which calculates plasma energy losses caused by bremsstrahlung, recombination, and resonance radiation. Either the Saha or corona model is used to calculate the ionization equilibrium of the impurity atoms. The major assumptions, method of calculation, and test results are discussed. (auth)

6538 FLUCTUATING MICROFIELD IN A SYSTEM OF CHARGED PARTICLES. Kogan, V. I.; Selidovkin, A. D. Beitr. Plasmaphys.; 9: 199-216(1969). (In Russian).

Some aspects of the theory of fluctuating microfield in a system of charged particles are considered. The question concerning regions of validity for Holtsmark-like and Gauss-like microfield distributions in a rarefied and a dense plasma is discussed. The influence of finite dimensions of particles (test particles as well as field particles) on the microfield distribution is investigated. Expressions for a "dynamic" (two-time) generalization of the Holtsmark distribution are obtained for limiting cases. By methods of microfield theory certain formulas for the fluctuations of the electric charges within a finite volume of an electrolyte are derived too. (auth)

6539 LANDAU DAMPING AND THE WATER-BAG MODEL. Rowlands, G. (Univ. of Warwich, Coventry, Eng.). Phys. Lett.; 30A 408-9(1 Dec 1969).

It is shown how the phenomenon of Landau damping arises in solutions of the water-bag model for the Vlasov equation. (auth)

6540 ELECTRON SPIN RESONANCE IN GASEOUS PLASMAS. Iannuzzi, M. (EURATOM–CNEN, Rome). Phys. Lett.; 30A: 423-4(1 Dec 1969).

The possibility of observing electron spin resonance in gaseous plasmas is discussed. The study of this resonance should be helpful as a new method for obtaining information on various plasma effects. (auth)

6541 ELECTRIC MICROFIELD DISTRIBUTIONS IN PLASMAS IN PRESENCE OF A MAGNETIC FIELD. Deutsch, C. (Faculte des Sciences, Paris). Phys. Lett.; 30A: 381-2(1 Dec 1969).

The low-frequency component of the electric microfield is seen to be rigorously unaffected by a magnetic field in a thermal plasma. (auth)

6542 FUNDAMENTALS OF ELECTROMAGNETIC PLASMA ACCELERATION. Patt, Hans-Josef (Technische Hochschule, Aachen. Peter-Wust-Hochschule, Saarbruecken, Ger.). VDI (Ver. Deut. Ing.) Z., 111: 1325-7(Oct. 1969). (In German).

The dynamical behavior of a plasma can strongly be influenced by electric and magnetic fields in consequence of the charged particles contained in them with relatively free mobility. Because of the relatively free mobility of charged particles in a plasma, its dynamical behavior can be strongly influenced by electric and magnetic fields. (tr-auth)

6543 A STATISTICAL DERIVATION OF THE HYDRODYNAMIC EQUATIONS OF CHANGE FOR A SYSTEM OF IONIZED MOLECULES. I. GENERAL EQUATION OF CHANGE AND THE MAXWELL EQUATIONS. Beshinske, R. J. (St. John's Univ., Jamaica, N. Y.); Curtiss, C. F. J. Statist. Phys., 1: 163-74 (1969).

Nonrelativistic, classical statistical mechanics is used to describe a dense fluid of molecules composed of nuclei and electrons with purely Coulomb interaction potentials. A general equation of change is derived for the time rate of change of any macroscopic (ensemble averaged) dynamical variable. From this general equation, Maxwell's equations in a medium are derived and expressed in terms of molecular properties, e.g., polarization and magnetization densities. (auth)

6544 HIGHER-ORDER CORRECTIONS TO THE THEORY OF THE GUIDING-CENTER PLASMA. Wilson, Gerald Earl. Madison, Wis.; Univ. of Wisconsin (1969). 77p.

Thesis.

The theory of the guiding-center plasma is extended to include higher-order terms of the series solution characterized by the parameter m/e. To do this, the single-particle equation is solved for the guiding-center velocities and accelerations correct to first order and the average diadic square of the particle instantaneous velocity is calculated. Then, by combining a microscopic Liouville equation, a macroscopic momentum equation, and a generalized Ohm's law with Maxwell's equations, a self-consistent system is defined. Finally, the equations are linearized in small perturbations about a uniform equilibrium configuration to obtain stability criteria. (Disser. Abstr.)

Production

6545 (BMwF-FBK-69-35) ON THE FORMATION OF THE INNER CHANNEL IN AN EXPLODING WIRE DISCHARGE AT HIGH AMBIENT PRESSURE. Binder, R. (Technische Universitaet, Hanover (West Germany). Institut fuer Plasmaphysik). Oct 1969. 39p. (In German). Dep. CFSTI (U. S. Sales Only).

An exploding wire discharge of a very thin tungsten wire (d = 0.01 mm) in nitrogen at high pressure (p = 100 atm) is investigated. The total radiated power of the discharge channel is determined from measurements of the absolute spectral radiant intensity in the near ultraviolet using absorption coefficients for the vacuum uv region calculated by Armstrong. About one half of the radiation energy emitted by the plasma column is absorbed in the cold ambient gas producing an intense photoionization. This process essentially brings about the growth of the discharge channel. Strong self-absorption of radiation in the plasma column effects a partial screening of the plasma near the axis against radiation energy loss. (auth)

6546 (RISO–206) EXPERIMENTAL INVESTIGATION OF MAGNETICALLY DRIVEN SHOCKS WITH AN ENERGY SOURCE OF CONSTANT VOLTAGE. Popovic, M. (Danish Atomic Energy Commission, Risoe, Research Establishment). Sep 1969. 48p. Dep. CFSTI (U. S. Sales Only).

A parametric study was made of the variation of the current and the current-sheet speed in a shock tube with parallel-plate electrodes and an energy source of constant voltage by varying the discharge voltage, the pressure, and the test gas. Interferometric studies demonstrated the presence of a nonluminous front preceding the luminous driving current at high pressures. Experimental results are compared with theoretical predictions derived from the snowplow model. Their discrepancies are discussed and explanations given whenever feasible. (auth) (Denmark)

6547 SPECTROSCOPIC SURVEY OF SELF-COMPRESSED ELECTRON-BEAM-PRODUCED PLASMAS. Rizzo, J. E. (Ion Physics Corp., Burlington, Mass.). J. Appl. Phys.; 40: 4883-5(Nov 1969).

The application of 1500-J self-focused 1.5-MeV electron pulses of 25-nsec duration to production of energetic plasmas was studied by time-resolved emission spectroscopy. In Ar and He at pressures of from 0.15 to 1.5 torr, a high-energy plasma is formed which continues radiating for up to 500 μsec. Under drifting electron beam conditions the He plasma appears to be doubly ionized. Measurements of excitation temperature from the relative intensities of neutral He lines fit an equilibrium model 2 μsec after the electron passage and indicate a temperature of 10,000°K falling to 5000°K by 400 μsec. A measurement of the width of the He(I) 4921-Å line indicates an electron density of 1.2×10^{15} cm^{-3} at 70 μsec, falling to 3.4×10^{14} cm^{-3} by 200 μsec. Studies of an Ar plasma have shown the emission at peak excitation to be in the Ar(IV) spectrum. When the beam exceeds its critical current and is stopped by its own magnetic compression, in Ar, the quenching of the Ar(IV) emission indicates that the plasma reaches an energy which is high compared to the 145 eV necessary to four times ionize and remains above this level for 8 μsec. (auth)

6548 INVESTIGATION OF GAS PROTECTION OF OPTICAL QUARTZ FROM HEATING BY DENSE PLASMA. Demidov, M. I.; Ogurtsova, N. N.; Podmoshenskii, I. V.; Rogovtsev, P. N. Zh. Prikl. Spektrosk.; 10: 191-6(Feb 1969). (In Russian).

Work was carried out on the protection of the quartz walls of discharge tubes from heat evolution by a dense plasma that increase the yield of ultraviolet radiation by quartz. A condenser battery with a capacity of 2100 microfarads and a potential of 5 kV was used. The battery provides a pulse of current with an amplitude of 50,000 A for approximately 4×10^{-4} sec. The discharge was produced in a fibrous tube with an end opened to the atmosphere, and had an internal diameter of 15 mm and a length of 80 mm. A plasma at 25,000°K was obtained and heat transfer on the walls of the tube was determined by radiation. A method of gas protection to protect the walls was proposed. Gas-generating materials such as cellulose and polyformaldehyde were used and the gas was released on heating by the electric discharge. (tr-auth)

Stability

Refer also to abstracts 6539, 6544, and 6569.

6549 (AD–693405) DISSIPATIVE INSTABILITIES OF AN MHD SHEET FLOW. Report on Plasma Research Project. Jager, Ernst H. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 30 Jun 1969. Contract F61052-67-C-0014. 19p. (UNICP-SR-65; AFOSR-69-2321-TR). CFSTI.

The stability of a sheet of flowing nonideal plasma is examined within linearized MHD. A general equation is obtained for the velocity perturbation of an assumed, nonstatic equilibrium. With all the equilibrium quantities constant, this equation gives the usual dissipative instabilities. A constant equilibrium flow velocity does not change the situation. Preliminary results obtained with variable (in space) equilibrium quantities are briefly discussed. They seem to indicate that a velocity profile across the sheet affects its stability in a new way. (auth) (USGRDR)

6550 (AD–694126) IDENTIFICATION OF THE COLLISIONAL DRIFT INSTABILITY BY USE OF CORRELATION TECH-

NIQUES. Mumola, P. B.; Powers, E. J. (Texas Univ., Austin. Electronics Research Center). 1968. 7p. (AFOSR-69-2350-TR). CFSTI.

A correlation is used to study the fluctuations in plasma density and potential present in an unstable weakly ionized cylindrical magnetoplasma. Autocorrelation measurements yield information concerning the frequencies of these fluctuations while spatial cross-correlation measurements allow one to determine their phase velocity and direction of propagation. Such measurements were made for a wide range of neutral pressures and magnetic field strengths. Results show that the unstable fluctuations have the same characteristic dependence on pressure and magnetic field as the well-known "drift" waves, that is, they propagate in the same direction and with the same velocity as the electron diamagnetic drift. (auth) (USGRDR)

6551 (NP-tr-1863) HYDROMAGNETIC STABILITY OF A CURRENT CARRYING PLASMA COLUMN IN A STRONG LONGITUDINAL MAGNETIC FIELD. Shafranov, V. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Culham Lab., Abingdon, Eng., from report IAE-1853. 26p. (CTO-661). Dep. CFSTI (U. S. Sales Only).

Earlier conclusions relating to the hydromagnetic stability of a current-carrying plasma column in a strong longitudinal magnetic field, based on investigating homogeneous and other special current distributions, are extended and refined. It is shown that, when $B_z \gg B_\theta$, the hydromagnetic perturbations leading to instability are clearly divided into localized flute perturbations and nonlocal surface-wave-type perturbations. In a plasma with free boundary, the main part is played by perturbations of the second type. The principal result is the demonstration that complete stabilization of these perturbations is possible, given a sufficiently rapid radial drop of the current density. The criteria for dissipative instabilities with reference to Tokamak-type systems are also discussed. (auth)

6552 OBSERVATION OF DRIFT WAVE INSTABILITY IN AN ARC PLASMA. Chung, Kun Mo (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). New Phys. (S. Korea), Suppl.; 9: No. 1, 15-25(Nov 1969).

A drift-wave instability is observed in a current-carrying collisional arc plasma. Results of the linear stability analysis are presented and a qualitative description of enhanced particle diffusion due to the instability is given as a consequence of nonlinear effects. The experimental data clearly support the identification of the instability and enhanced diffusion of particles by the presence of the instability. (auth)

6553 SHEAR STABILIZATION OF DRIFT CYCLOTRON INSTABILITIES IN PLASMAS. Davidson, James N. (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 12: 722(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Thermonuclear Processes

6554 (AD-693125) ELECTRODE METAL EFFECTS IN A DEUTERIUM PLASMA Z-PINCH DEVICE. Technical Report, March-December 1968. Dazey, Mitchell H.; van Paassen, Hugo L. L.; Josephson, Vernal (Aerospace Corp., El Segundo, Calif.). 8 Aug 1969. Contract F04701-69-C-0066. 16p. (TR-66(5220-50)-2; SAMSO-TR-69-230). CFSTI.

The introduction of the hydrogen-gettering metals titanium and zirconium in a paraboloidal plasma Z-pinch device produced a substantial increase in the neutron yield. Yields up to 3×10^{10} neutrons per shot were obtained using titanium-tipped electrodes in deuterium gas with an 18-kJ energy source. The effect of these metals in increasing the neutron yield is sensitive to the compression obtained in this pinch device. This effect is small or nonexistent in Z-pinch devices with cylindrical electrodes where the space between the anode and cathode is large in the region of the pinch. (auth) (USGRDR)

6555 (NP-tr-1860) MAGNETIC FIELD STRUCTURE IN THE TOR-1 STELLARATOR WITH $l = 2$. Andryukhina, E. D.; Fedyanin, O. I.; Kholnov, Yu. V. Translated for Culham Lab., Abingdon, Eng., from Preprint No. 118. 16p. (CTO-662) Dep. CFSTI (U. S. Sales Only).

The results of magnetic measurements in TOR-1 are reported. The existence of closed surfaces is experimentally confirmed. The resonance region is investigated. The maximum rotational transform is $i \simeq 4$ to 4.5, with a maximum shear $\theta \simeq 3 \times 10^{-2}$. (auth)

6556 SPHERICAL MULTIPOLE MAGNETS FOR PLASMA RESEARCH. Sadowski, M. (Inst. of Nuclear Research, Warsaw). Rev. Sci. Instrum.; 40: 1545-9(Dec 1969).

Spherical multipole (SM) magnetic fields are used for plasma containment. Such magnetic fields are produced by magnetic dipoles symmetrically placed on the sides and the edges of regular polyhedrons. In the paper, field configuration of the high-order SM systems is considered and some basic problems regarding the design of SM electromagnets are discussed. Relations are given relating magnetic field, power input, current- and temperature-time characteristics. The construction and operation of the "Kaktus" magnet are also described. (auth)

6557 ANALYSIS OF THE LINEAR HELICAL HELIOTRON FIELD. Matsuda, Shinzaburo; Mohir, Akihiro (Kyoto Univ.). Kakuyugo Kenkyu; 23: 346-66(Oct 1969). (In Japanese).

An average minimum magnetic field with inner conductors for plasma confinement can be generated when current-carrying helical conductors are placed in a uniform magnetic field. The helical currents are axially unidirectional and the axial field component produced by the currents is inverse to the uniform field near the axis. Inside the conductors, this axial component diminishes the uniform field, so that an average minimum field can be realized. This magnetic field has both properties of multipole field and the Heliotron P field (multi-ring system + uniform field). When the pitch of the helical conductors is large compared with its radius, the properties of the multipolar field dominates, whereas the field with short pitch is like the Heliotron P field. The magnetic field is examined for linear configurations. The helical currents are expressed by the Fourier expansion, and potentials $U = -\int dl/B$ and $-\int dl$ are computed by a digital computer. The ratio of the helical field on the axis to the uniform field is used as a parameter of the field configuration. It becomes evident that, at appropriate values of the parameter, closed magnetic surfaces appear near the axis and very deep potential wells are formed. The rotational transform is also very large. (NSA of Japan)

Wave Phenomena

6558 (AD-694110) RESISTIVE DRIFT WAVES IN AN INHOMOGENEOUS ADIABATIC PLASMA. Auer, Gerhard (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 15 Jul 1969. Contract F61052-67-C-0014. 18p. (UNICP-SR-66; AFOSR-69-2437-TR). CFSTI.

The propagation of drift waves in an inhomogeneous plasma immersed in a strong magnetic field is studied. The analysis is based on a macroscopic two-fluid model. Electron inertia and finite resistivity are taken into account. The equilibrium configuration is characterized by a density gradient perpendicular to the magnetic field. The dispersion relation for the normal modes is derived under the assumption of adiabatic behavior of the plasma. (auth) (USGRDR)

6559 (AD-694499) ELECTROMAGNETIC WAVE PROPAGATION IN UNIAXIAL PLASMAS WITH CURVED MAGNETIC FIELD. Report No. Scientific-5. Stalzer, Henry J. Jr.; Shmoys, Jerry; Felsen, Leopold B. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Electrophysics). Jul 1969. Contract F19628-68-C-0072. 196p. (PIBEP-69-24; AFCRL-69-340). CFSTI.

The effect of the curvature of an impressed static magnetic field on the propagation and diffraction of electromagnetic waves in a uniaxial plasma is studied. The model chosen for the analysis is two-dimensional, with the magnetic field lines consisting of concentric circles. Ray optical techniques are used to construct approximate solutions to the field radiated from a line source in the unbounded medium and one into which a perfectly conducting or a transparent cylinder is introduced. The radiated, reflected, refracted, and diffracted fields calculated by ray optics are then validated by obtaining exact integral representations for the solutions to several canonical problems and evaluating these integrals asymptotically for high frequencies. The agreement between the ray optical results and the asymptotic approximations validates the ray optical procedure and suggests its usefulness in obtaining approximate solutions to more general configurations which are not amenable to a rigorous analysis. The center of curvature of the magnetic field lines in the unbounded medium acts as a scatterer and is shown to be analogous to the vertex of a wedge. When cylindrical boundaries are introduced, the diffracted field consists of creeping rays excited by rays that are incident either tangentially or at the critical angle. (auth) (USGRDR)

6560 (IPP-3/94) PROPAGATION AND FRESNEL EFFECT OF MICROWAVES IN A WAVEGUIDE PARTIALLY FILLED WITH A COLD PLASMA DIELECTRIC. Gehre, O.; Mayer, H. M.; Tut-

ter, M. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Jun 1969. 24p. Dep. CFSTI (U. S. Sales Only).

The propagation of electromagnetic waves through a circular waveguide partially filled with a homogeneous, lossless and nonmagnetic dielectric rod are studied. The characteristic equation is a transcendental equation where the unknown wave numbers appear in the arguments of Bessel and Neumann functions. Approximate analytical solutions are found by appropriate approximations of these functions for the case where the dielectric discontinuity is small and the roots of the equation lie in the neighborhood of the roots for the empty guide. The results are used to give a rough theory for the Fresnel dragging effect on microwaves by the positive column of a glow discharge that burns inside a waveguide. It is shown that symmetric modes of the H (or TE) type show no effect. Of all the other modes, only the three lowest modes are treated in detail. These are the E_{01}, the H_{11}-like, and the E_{11}-like modes. For low plasma densities the effect is linear for the electric and of higher order for the magnetic modes in plasma density. Comparison with measurements is made and rough agreement is obtained. Some details of the experimental curves, however, cannot be explained. At the present stage the remaining discrepancies seem to be more likely due to end and finite-length effects than due to hot plasma properties. (auth)

6561 EFFECT OF RADIATION REACTION ON PLASMA WAVES. Burman, R. (Univ. of Western Australia, Perth). Phys. Lett.; 30A: 431(1 Dec 1969).

The integro–differential equation of motion for a point electron is used in the Vlasov equation to obtain a dispersion relation for longitudinal waves. (auth)

6562 ION–ION RESONANCES IN A MAGNETIZED PLASMA CYLINDER. Babu, R.; Oakes, M. E. (Univ. of Texas, Austin). Phys. Lett.; 30A: 433-5(1 Dec 1969).

Main resonances in a magnetized two-ion-component plasma cylinder are calculated and discussed. (auth)

6563 LINEAR DAMPING OF A SINUSOIDAL OSCILLATION IN A PLASMA. Pocobelli, G. (Univ. of Saskatchewan, Saskatoon, Can.). Can. J. Phys.; 47: 2603-8(1 Dec 1969).

The linearized Vlasov equation for a plasma is solved by means of integration along the particle trajectories assuming an oscillatory electric field of variable amplitude. A procedure is established which gives exactly the Landau–Jackson dispersion equation, showing that if the assumption of the constancy of amplitude of the electric field is removed, then O'Neil's method of integration of the nonlinear Vlasov equation yields the correct result in the linear limit. A simple application of the present formalism allows a determination of the earliest time at which the Landau damping law becomes valid for an arbitrary stationary distribution (previous work is limited to the case of a Maxwellian distribution) and initial perturbation. The minimum value of this time as a function of wave number is calculated explicitly for a Maxwellian stationary distribution. (auth) (Canada)

6564 FIELD OF A GROWING ELECTROMAGNETIC WAVE ON A BEAM–PLASMA SLAB. Gupta, K. C. (Indian Inst. of Tech., Kanpur); Singh, A. Int. J. Electron.; 27: 189-92(Aug 1969).

The effect of growth of electromagnetic waves on the transverse variation of the field of a wave guided along a beam–plasma slab is described. It is found that there is a component of the power flow normal to the slab. The magnitude of this normal component (directed outwards) is proportional to the imaginary part of the propagation constant. (auth) (UK)

6565 NONLINEAR OSCILLATIONS OF DRIFT WAVES IN AN INHOMOGENEOUS PLASMA. Kadomtsev, B. B.; Pogutse, O. P. Dokl. Akad. Nauk SSSR; 188: 69-72(1 Sep 1969). (In Russian).

The instabilities of an inhomogeneous plasma in a strong magnetic field are due to the low amplitude of oscillations of drift waves, which may be analyzed by means of the linear approximation. However, even at low amplitudes, there might be effects resulting from the appearance of a new group of particles from the potential wells of the waves; the properties of these particles may differ from the properties of particles moving in a homogeneous magnetic field in the absence of the wave. It is shown that when the collision frequency of the electrons is about the same as the drift frequency and the direction of the temperature gradient in the plasma is opposite to the density gradient, finite-amplitude drift waves on electrically blocked electrons may be generated. The resulting instability due to the dissipation during the transition of electrons from the block to the transit type, is similar to that of the magnetically blocked electrons in toroidal systems. The calculations indicated that under certain conditions the weakly nonlinear drift wave could increase in time at a much faster rate than in the linear approximation. (TTT)

6566 ON THE EFFECT OF VARIABLE MAGNETIC FIELD ON THE STABILITY OF LANGMUIR OSCILLATIONS OF PLASMA WHICH IS IN THE MAGNETIC FIELD. Nekrasov, F. M. (Inst. of Physics and Tech., Sukhum, USSR). Ukr. Fiz. Zh., 14: 1493-8(Sept. 1969). (In Russian).

The solution is carried out in drift approximation without regard of the thermal motion in plasma. Plasma oscillations are unstable at $k_y/k_z\ h_0/H_0 \gtrsim 1$, where h_0 and H_0 are the strengths of variable and constant magnetic fields. The order of the instability increment magnitude is calculated. (auth)

6567 NONLINEAR INTERACTIONS OF POSITIVE AND NEGATIVE ENERGY MODES IN RAREFIED PLASMAS. I. Coppi, B. (Princeton Univ., N. J. Inst. for Advanced Study, Princeton, N. J.); Rosenbluth, M. N.; Sudan, R. N. Ann. Phys. (N.Y.); 55: 207-47(Nov 1969).

The nonlinear interactions of electrostatic modes in a plasma are studied within the framework of the weak-turbulence approximation. It is shown that the multi-wave interaction (resonant mode–mode coupling) can be explosively unstable when, for $\Sigma_{j=1}^{n} k_j = 0$ and $\Sigma_{j=1}^{n} \omega_{kj} = 0$, one also has $S_1 = S_2 = \cdots = S_n$, where $S_j = (\partial\epsilon/\partial\omega_{kj})/|\partial\epsilon/\partial\omega_{kj}|$, n being the number of interacting waves and ϵ the dielectric constant. Significant examples are analyzed with special consideration for that of a plasma with a loss-cone distribution in a strong magnetic field B. This in fact can have positive and negative energy modes, for which unstable three-wave interactions can occur with growth rates which are appreciable for rather modest intensities. The modes considered are of flute type, with $k \cdot B = 0$, so that convection along the lines of force does not affect the validity of the above results. A nonlinear mechanism of the type analyzed here can provide a possible explanation of the bursts of radiation often associated with low-density mirror-confined plasmas. (auth)

6568 NONLINEAR INTERACTIONS OF POSITIVE AND NEGATIVE ENERGY MODES IN RAREFIED PLASMAS. II. Rosenbluth, M. N. (Inst. for Advanced Study, Princeton, N. J. Princeton Univ., N. J.); Coppi, B.; Sudan, R. N. Ann. Phys. (N.Y.); 55: 248-70(Nov 1969).

It is shown that the process of nonlinear Landau scattering (two-wave particle interaction or nonresonant mode–mode coupling) can also lead to instability. In the absence of magnetic field the nonlinear Landau scattering occurs for particles of velocity v such that $\omega_{k'} + \omega_{k''} + (k' + k'') \cdot v = 0$ and the corresponding instability condition is $S_k(k + k') \cdot \int (\partial f/\partial p)\, d^3p > 0$. Here $S_k = (\partial\epsilon/\partial\omega_k)/|\partial\epsilon/\partial\omega_k|$, ϵ being the dielectric constant of the considered electrostatic modes. For a plasma in a magnetic field, the resonant condition is $\omega_k + \omega_{k'} = l\Omega_c$, $l\Omega_c$ being a multiple of the ion cyclotron frequency, for flute-type modes with $k \cdot B = 0$ such that all particles are simultaneously resonant. The condition for nonlinear growth is $S_k = S_{k'}$ and $(\omega_k + \omega_{k'})\, S_k \int (\partial f/\partial E)\, |V(E)|^2\, dE > 0$. The relevant matrix element V(E) is evaluated by using the principle of detailed balance with the simple process of single-particle scattering of waves. The significant example analyzed is that of a loss-cone distribution for a plasma in a magnetic field. The most relevant unstable interaction involves a positive and a negative energy mode, the latter with the larger frequency, and the effective amplitude growth rate is shown to be appreciable for rather modest intensities. A special case of nonlinear Landau damping occurs when the two waves are the same, but the relevant nonlinear instability does not, in general, occur for loss-cone distributions unless a density gradient is present. (auth)

6569 EXPLOSIVE PLASMA INSTABILITIES. Fukai, J.; Krishan, S.; Harris, E. G. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 23: 910-12 (Oct. 20, 1969).

The explosive instability caused by the nonlinear interaction of two positive energy waves and one negative energy wave and its stabilization by higher-order nonlinear effects are discussed. (auth)

6570 MAGNETO–ACOUSTIC DISTURBANCES IN A WARM VLASOV PLASMA. Kinsinger, Richard Estyn. Ithaca, N. Y.; Cornell Univ. (1969). 178p.

Thesis.

The propagation of both linear and nonlinear, pulse-type disturbances in a collisionless magnetoplasma with temperature is studied. The geometry assumed is magneto-acoustic or that of propagation exactly perpendicular to an axial magnetic field. The plasma is taken to be two-component (electrons and one ion species), and for most of the study, the undisturbed distribution functions are left as unspecified. Relativistic effects are ignored

throughout. Finally, one assumes that mean free lengths and times are such that collisional effects can be ignored over the scale of the disturbance. The Vlasov equation is therefore used as a kinetic equation for each species. (Disser. Abstr.) (TSS)

Shielding

Refer also to abstracts 6254, 6704, 6779, 6780, and 6789.

6571 (AD–693618) GAMMA-RAY TRANSPORT IN LIQUID NITROGEN. Final Report. Reynolds, G. M.; Benham, B. P.; Russell, J. L. Jr.; Selph, W. E.; Sperling, S. M. (Gulf General Atomic, Inc., San Diego, Calif.). 30 May 1969. Contract DASA01-68-C-0088. 79p. (GA–9429; DASA–2331). CFSTI.

An important part of the radiation dose in the transport of fast neutrons through matter is the nuclear gamma radiation. Confidence in the ability to calculate the production and transport of the gamma radiation can be gained by comparison with measurements, preferable with simple geometry. This study concerns ^{14}N because of its importance in the air transport problem. A Cockcroft–Walton type neutron generator produced a source of 14-MeV neutrons in the center and near the bottom of a large cylindrical tank of liquid nitrogen. Gamma rays produced by the interaction of these 14-MeV neutrons with the nitrogen nuclei were detected with a lithium-drifted germanium detector. Separation of the fast gamma spectrum from the thermal-capture spectrum was effected by pulsing the neutrons. The simple geometry approximates a point neutron source in an infinite medium of liquid nitrogen. (auth) (USGRDR)

6572 (AD–854520) EXPERIMENTAL VERIFICATION OF NEUTRON AND GAMMA-RAY TRANSPORT CALCULATION IN LITHIUM HYDRIDE AND TUNGSTEN. Technical Report, November 1967–September 1968. Profio, A. E.; Cerbone, R. J.; Huffman, D. L. (Gulf General Atomic, Inc., San Diego, Calif.). May 1969. Contract F29601-68-C-0022. 213p. (GA–9029; AFWL–TR–68-138). CFSTI.

Measurements of the neutron angular flux spectrum from ~0.1 eV to 15 MeV were made in a 91.4-cm-diameter sphere of lithium hydride, using the pulsed-source, time-of-flight method. These measurements were compared with 05R Monte Carlo and DTF-IV discrete ordinates calculations to test computational methods and nuclear data for LiH shields. The fast neutron data for LiH appear to be rather good except for the angular distributions. The discrete ordinates code underpredicts the low-energy flux. An asymmetric quadrature set was develped to reduce computer storage requirements for the discrete ordinates calculations. Measurements of the neutron angular flux spectrum below 200 eV and the secondary gamma-ray spectrum from 200 keV to 10 MeV were made in a laminated sphere of tungsten and lithium hydride. Discrepancies were noted between measurement and DTF-IV neutron calculations especially in the tungsten at the energies of strong resonances. A secondary gamma-ray source code was written and calculations of gamma-ray production and transport were performed. (auth) (USGRDR)

6573 (ORNL–TM–2719) THE 1969 RSIC COMPUTER-BASED INFORMATION RETRIEVAL SYSTEM IN BRIEF. Jones, J. G.; Trubey, D. K.; Gurney, J. (Oak Ridge National Lab., Tenn.). 14 Nov 1969. 29p. Dep. CFSTI.

The computer-based information retrieval system used by the Radiation Shielding Information Center (RSIC) since 1963 has been reprogrammed to take advantage of modern computer hardware and software. A brief description of the system is given to aid those using it and to inform those who might use it for their own information files. (auth)

6574 (UCRL-Trans–10393) GAMMA RAYS FROM THE RADIATIVE CAPTURE OF RESONANCE AND FAST NEUTRONS. Bakov, A. T.; Kazanskii, Yu. A. Translated by T. Watt for Univ. of California Lawrence Radiation Lab., Livermore, from pp 156-63 of Voprosy Fiziki Zashchity Reaktorov, Atomizdat, Moscow, 1966. 24p. Dep. CFSTI.

An attempt is made to survey all the published material on the spectra of gamma rays from fast-neutron capture. The review covers the period up to January 1, 1964. (M.H.R.)

6575 EXPERIMENTAL DETERMINATION OF PHOTON ENERGY DISTRIBUTIONS FOR ^{60}Co AFTER PENETRATION OF THICK CONCRETE BARRIERS. Starchman, Dale Edward. Manhattan, Kan.; Univ. of Kansas (1968). 71p.

Thesis.

Energy distributions of a broad beam of ^{60}Co gamma rays scattered by thick concrete barriers were measured as functions of the angle at which the photons were detected and of the barrier thickness. For thin slabs, the scattering of photons by single collisions provides the most significant component of the photon energy distribution at all angles greater than 0°. For increased thicknesses of concrete, the importance of the scattering of photons after multiple collisions is enhanced. The importance of singly scattered radiation is greater in comparison with multiply scattered radiation for small angles than for large angles of scattering. With increasing thicknesses of concrete, the energy distribution shifts toward the lower energies, but the rate of change is less with increasing thickness. For thin slabs, additional concrete acts to increase the amount of scattered radiation until some optimum thickness is reached. The subsequent addition of concrete causes more photons to be absorbed than it causes to be scattered at that particular angle. After an initial "semi-equilibrium" thickness of concrete is reached, the effect of the addition of concrete to the barrier on the total number flux of photons measured is the same for all angles of scattering greater than 0°. (Diss. Abstr. Int., B)

6576 TEMPERATURE-DEPENDENT SELF-INDICATION RATIO STUDIES ON 1.15-keV RESONANCE IN ^{56}Fe. Shea, T. E. (Brookhaven National Lab., Upton, N. Y.); Purohit, S. N.; Byoun, T. Y.; Block, R. C. Trans. Amer. Nucl. Soc., 12: 755-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6577 THRUST OF CROSS-SECTION DATA REQUIREMENTS FOR REACTOR SHIELDING CALCULATIONS. Penny, S. K. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 921(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6578 NUCLEAR DATA GENERATION AND ANALYSIS FOR SHIELDING APPLICATIONS. Yost, K. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 922(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6579 MEASUREMENTS OF NUCLEAR DATA FOR SHIELDING USING A LINAC. Orphan, V. J. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 922-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6580 THEORY OF NEUTRON CROSS SECTIONS FOR SHIELDING. Moldauer, P. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 921-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6581 CALCULATION AND EVALUATION OF POPOP4 MULTIGROUP, SECONDARY GAMMA-RAY PRODUCTION CROSS SECTIONS. Ford III, W. C.; Wallace, D. H. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 930-2 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6582 SHIELDING PROBLEMS OF A NUCLEAR-POWERED MANNED ORBITAL SPACE STATION. Keshishian, Vahe (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 422(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6583 INTERACTIONS BETWEEN RADIATION FIELDS FROM RADIOISOTOPE THERMOELECTRIC GENERATORS AND SCIENTIFIC EXPERIMENTS ON SPACECRAFT. Miller, C. G.; Truscello, V. C. (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc., 12: 474-5(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6584 NEUTRON SHIELDING PROBLEMS IN HIGH BURNUP THERMAL REACTOR FUEL SHIPPING. Bailey, H. S.; Evatt, R. N.; Ruiz, C. P.; Gyorey, G. L. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 448-9(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6585 KERNEL METHODS FOR RADIATION SHIELDING CALCULATIONS. Trubey, K. K. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 943-4(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6586 A REVIEW OF SOME RECENT MULTIDIMENSIONAL DISCRETE ORDINATES SHIELDING CALCULATIONS. Mynatt,

Fred R. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 944(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6587 PRACTICAL ASPECTS OF MULTIDIMENSIONAL AND TIME-DEPENDENT MONTE CARLO SHIELDING CALCULATIONS. Mittelman, Phillip S.; Kalos, Malvin H. (Mathematical Applications Group, Inc., White Plains, N. Y.). Trans. Amer. Nucl. Soc., 12: 944-5(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6588 ADVANCED MONTE CARLO CONCEPTS: METHODS AND APPLICATIONS. Jordan, T. M. (ART Research Corp., Los Angeles). Trans. Amer. Nucl. Soc., 12: 945(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6589 NONHYDROGENOUS SHIELD TEST CORRELATIONS. Specht, E. R. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 946-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6590 MONTE CARLO GRAPHITE BENCHMARK CALCULATION USING S_n ADJOINT BIASING. Cramer, S. N. (Union Carbide Corp., Oak Ridge, Tenn.); Cain, V. R.; Straker, E. A. Trans. Amer. Nucl. Soc., 12: 947-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6591 EXPERIENCE WITH LAGUERRE NUMERICAL INTEGRATION IN POINT KERNEL SHIELDING CALCULATIONS. Mesh, D. W.; Cochrane, P. C. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 12: 948-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6592 STOCHASTIC GAMMA-RAY TRANSPORT AND ITS APPLICATION TO SHIELDING CALCULATIONS. Razani, Arsalan; Hungerford, H. E. (Purdue Univ., Lafayette, Ind.). Trans. Amer. Nucl. Soc., 12: 950-1(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6593 GROUND HEATING DUE TO A POINT SOURCE OF 12.2- TO 15-MeV NEUTRONS AT AN ALTITUDE OF 50 FT. Straker, E. A.; Emmett, M. B.; Thompson, C. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 954-5 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6594 INFINITE-MEDIUM NEUTRON AIR TRANSPORT BUILDUP AND CORRECTIONS FOR AN EXPONENTIAL ATMOSPHERE. Celnik, J. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 12: 955-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6595 NEUTRON ENERGY FLUX IN AN EXPONENTIAL ATMOSPHERE. Raso, Dominic J. (ARCON Corp., Wakefield, Mass.). Trans. Amer. Nucl. Soc., 12: 957-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6596 NEUTRON AND SECONDARY GAMMA-RAY MEASUREMENTS IN LIQUID NITROGEN. Harris, R. J. Jr.; Reynolds, G. M.; Selph, W. E.; Sperling, S. M. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 958-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6597 FAST-NEUTRON AND SECONDARY GAMMA-RAY TRANSPORT IN CONCRETE. Harris, L. Jr.; Kendrick, H. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 959-60(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6598 MEASURED FAST-NEUTRON SPECTRA AFTER REFLECTION OF FISSION SOURCE NEUTRONS FROM A SIX-INCH-THICK STEEL SLAB. Meyer, Walter (Kansas State Univ., Manhattan); Simons, Gale G. Trans. Amer. Nucl. Soc., 12: 960-1(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6599 ESTIMATION OF SPATIAL CAPTURE DISTRIBUTIONS IN RESONANCE ABSORBERS. Bogart, Donald (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 12: 965-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6600 EFFECT OF ^{238}Pu ON SHIELDING REQUIREMENTS FOR RTG SPACECRAFT EXPERIMENTS. Dore, Michael A.; Truscello, Vincent C. (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc., 12: 966(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6601 GAMMA-RAY ATTENUATION AT 6 AND 8 MeV. Johnson, W. R.; Risher, D. H.; Rogers, J. E.; Thompson, W. L. (Univ. of Virginia, Charlottesville). Trans. Amer. Nucl. Soc., 12: 967(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6602 MEASUREMENT OF THICK TARGET BREMSSTRAHLUNG FROM TIN AT 4.0 AND 8.0 MeV. Costello, D. G.; Weber, Hans; Lonergan, J. A. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 968(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6603 FREE-NUCLEON TARGET MODEL APPLIED TO NUCLEON PENETRATION THROUGH MATTER. Wright, H. A.; Turner, J. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 968-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6604 NEUTRON SHIELDING PROBLEMS ASSOCIATED WITH THE SHIPMENT OF HIGH-BURNUP LWR FUEL. Rollins, J. D.; Best, R. E. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 970(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6605 NEUTRON STREAMING IN HELICAL DUCTS. Jordan, T. M. (ART Research Corp., Los Angeles); Wohl, M. L. Trans. Amer. Nucl. Soc., 12: 949-50(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6606 CALCULATIONS OF WEAPONS RADIATION DOSES IN SINGLE-COMPARTMENT ABOVEGROUND CONCRETE STRUCTURES. Mooney, L. G. (Radiation Research Associates, Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 12: 962 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6607 DISK SOURCE EXPOSURE ANGULAR DISTRIBUTIONS. Rubin, R. M.; Faw, R. E. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 12: 962-3(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6608 A SHIELD OPTIMIZATION TECHNIQUE WITH DIRECT UTILIZATION OF TRANSPORT CALCULATIONS. Engle, W. W. Jr.; Mynatt, F. R. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 953(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6609 PREDICTION OF NUCLEAR WEAPON NEUTRON RADIATION ENVIRONMENTS. French, R. L.; Mooney, L. G. (Radiation Research Associates, Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 12: 954(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

Solid-State Physics

6610 ION IMPLANTATION TO FORM CONDUCTIVE CONTACT. Manchester, Kenneth E. (to Sprague Electric Co.). U. S. Patent 3,481,776. 2 Dec 1969. Filed 18 Jul 1966.

Conductive contacts are extended through an overlying protective coating of an electronic device without opening of the coating, by ion implantation in which ion penetration is varied through the

coating thickness to form a conductive path from the device to the outer surface of the coating. (Offic. Gaz.)

Radiation Effects

Refer also to abstracts 5966, 6206, 6218, 6260, 6274, and 6342.

6611 (CEA-R-3854) STUDY OF POINTS DEFECTS PRODUCED BY IRRADIATION OF MONOCRYSTALLINE NICKEL AND POLYCRYSTALLINE GADOLINIUM. Cope, Robert (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). July 1969. 57p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The work described in this thesis falls into two parts: (1) a study of magnetocrystalline nickel by resistivity measurements; and (2) a description of resistivity and magnetic after-effect measurements on an hcp ferromagnetic crystal other than cobalt, namely gadolinium. For the first part, the existence of a small but definite orientation dependence was demonstrated in the creation of point defects by electron irradiation (20°K) of a nickel single crystal. In particular, the effect is manifested in the form of the stage I_C, II, and III in the resistivity recovery. In the second part, there is no magnetic after-effect phenomenon in a neutron-irradiated (27°K) ferromagnetic metal. A preliminary interpretation of this important difference between gadolinium and cobalt is discussed. (auth)

6612 (NYO-3504-38) DEFECTS PRODUCED IN SILVER BY keV SILVER ION BOMBARDMENT. Report No. 1268. Schober, T. (Cornell Univ., N. Y. Dept. of Materials Science and Engineering). 30 Oct 1969. 17p. Dep. CFSTI.

The nature and production mechanism of small defect clusters produced in single-crystal silver films by room-temperature bombardment with 5- to 50-keV silver ions along [001] at low dose levels (10^{10} to 10^{12} ions cm^{-2}) was studied using electron microscopy. The defects were found to be of vacancy type over the entire energy range. At low energies (5 and 10 keV), most of the defects displayed the diffraction contrast typical of a radial strain field; at the higher energies, a mixture of Frank loops and stacking-fault tetrahedra was found. It was concluded that the defects were formed through the in situ collapse of vacancy-rich regions produced by displacement cascades. In general, the present results are very similar to those obtained by Thomas et al. for gold bombarded with keV gold ions. The results are compared with those of several other related investigations. (auth)

6613 ACTIVATION ENERGY FOR ANNEALING DEFECTS FORMED IN THIN SILVER FILMS BY PROTON BOMBARDMENT. Chechetenko, V. V.; Tishchenko, L. P.; Fogel, Ya. M.; Belov, A. G. (Physical-Technical Inst. for Low Temperature, Kharkov. Gorky State Univ., USSR). Sov. Phys.-Solid State (Engl. Transl.); 11: 1122-3(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1384-6(May 1969).

The activation energies for the recombination of pair defects and the diffusion of interstitial hydrogen atoms were determined for proton-bombarded silver films with $\lambda/d \sim 1$ and $\gg 1$ (λ = proton path and d = film thickness). For the recombination, the activation energy tends to increase with temperature. The results are of the same order of magnitude as that of the activation energies for migration of point defects and protons in silver. (D.L.C.)

6614 SIMULTANEOUS MEASUREMENT OF SPUTTERED CONSTITUENTS OF Cu_3Au. Ogar, W. Thomas; Olson, N. Thomas; Smith, Harold P. Jr. (Univ. of California, Berkeley). J. Appl. Phys.; 40: 4997-8(Nov 1969).

The Cu and Ag sputtering yields in the sputtering of disordered Cu_3Au by Hg^+ and Ar^+ ions were measured by a radioactive tracer technique, using ^{64}Cu and ^{198}Au formed by neutron irradiation. The total yield, ~20 atoms/ion for Hg^+ ions, is greater than that for either pure Cu or Au, and Au is sputtered slightly in excess of its stoichiometric abundance. (D.L.C.)

6615 SPUTTERING EXPERIMENTS WITH 1 TO 5-keV Ar^+ IONS. DISPLACEMENT OF EJECTION PATTERN SPOTS. Robinson, Mark T. (Oak Ridge National Lab., Tenn.). J. Appl. Phys.; 40: 4982-3(Nov 1969).

The ejection patterns from ion bombardment of {111} surfaces of fcc metals include three spots near the ⟨114⟩ direction. It is shown that the ⟨114⟩ spots can be associated with preferential ejection from lattice sites in ⟨100⟩ directions. Calculations are made for the deflection of ⟨100⟩ directed Cu atoms passing through a {111} surface. (D.L.C.)

6616 A STUDY OF IRRADIATION-INDUCED POINT DEFECTS IN TUNGSTEN. Stabell, Donald Edward. Pittsburgh; Univ. of Pittsburgh (1968). 128p.

Thesis.

The dependence of the internal friction and resonant frequency of vibration of cantilevered tungsten rods on irradiation dose and temperature was studied. Most of this study focused upon 99.98% pure polycrystalline tungsten wires and 99.999% pure tungsten single crystals of selected crystallographic orientation. Both 9.0- and 11.1-MeV proton irradiations of these samples (maintained at or below 15°K) revealed initial dislocation pinning and a subsequent "bulk effect." The average bulk effect was $d \ln M/d\phi = -.046\%/10^{16}$ p/cm², where M is Young's modulus. Annealing studies performed after the irradiations revealed five irradiation-induced internal friction peaks at approximately 10, 14, 30, 42, and 53°K for a 1-KHz resonant frequency. The processes occurring near 10 and 14°K produce stable internal friction peaks, and therefore result from defect reorientation without migration. A computerized lattice simulation was performed, chiefly as a means of studying the bulk effect for individual defect types. A two-body interaction potential which fits the observed elastic constants and lattice parameter of tungsten was utilized. The results for tungsten are $d \ln K/d\gamma = -2.5$ for vacancies, and $d \ln K/d\gamma = +1.4$ for interstitials, where K is the bulk modulus and γ is the fractional atomic defect concentration. Thus a negative bulk effect is predicted. (Diss. Abstr.)

6617 FORMATION KINETIC STUDY OF AGGREGATE COLOR CENTERS WITH ZERO-PHONON LINES IN NaF. von der Osten, W.; Riemenschneider, K. (Technische Hochschule, Darmstadt, Ger.). Solid State Commun.; 7: 1551-3(Nov 1969).

The formation of aggregate color centers during x- or γ irradiation has been used successfully to derive some knowledge about the models of these centers. Formation kinetic measurements for a number of F aggregate color centers in NaF were performed using the zero-phonon absorption lines 5456, 5754, and 6070 Å as well as the F, M, and R_2 absorption bands. Taking into account the color center symmetries obtained from uniaxial stress experiments, several possible models for the centers that gave rise to the zero-phonon lines are discussed. (UK)

6618 ESR OBSERVATION OF FRENKEL-DEFECT PRODUCTION BY POST-IRRADIATION ELECTRON-HOLE RECOMBINATION IN KCl. Keller, F. J.; Patten, F. W. (Naval Research Lab., Washington, D. C.). Solid State Commun.; 7: 1603-7(Nov 1969).

Experiments are described in which the creation of H centers is detected as a result of electrons recombining with V_k-type centers. The results are interpreted as evidence favoring the excitonic mechanism for radiation damage in alkali halides. (auth) (UK)

6619 PARAMAGNETIC CENTERS IN ULTRAVIOLET AND X-IRRADIATED POTASSIUM SULFATE. Hariharan, N.; Sobhanadri, J. (Indian Inst. of Tech., Madras). J. Magn. Resonance; 1: 639-47(Nov 1969).

Single crystals of potassium sulfate were grown from aqueous solution and irradiated with ultraviolet and x radiation. An analysis of the ESR spectra of the induced magnetic centers revealed that in addition to SO_4^- and SO_3^- already identified in γ-irradiated potassium sulfate, several new lines were present. The six-line spectrum was assigned to an anisotropic paramagnetic center interacting with ^{39}K and H trapped in the crystal. The spectrum due to O_3^- was found to be isotropic at room temperature and anisotropic at 77°K. Optical and thermal annealings were performed to identify the centers. The principal values of the g tensor of SO_4^- and its direction cosines are compared with the values of previous investigators. (auth) (UK)

6620 STUDY OF THE ANISOTROPY OF RADIATION DAMAGE RATES IN n-TYPE SILICON. Hemment, P. L. F.; Stevens, P. R. C. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Appl. Phys.; 40: 4893-4901(Nov 1969).

Consideration of the factors influencing electron radiation damage led to the development of a computer program to predict damage rates as a function of electron beam energy and crystal orientation with respect to the beam. Experimental results using low-energy electrons (in the range 100 to 400 keV) are presented, which show the carrier removal rate as a function of sample orientation and electron beam energy. These measurements supplement the earlier results of Haddad and Banbury. Comparison of the calculated and experimental results enables one to make suggestions about the form of the displacement energy as a function of direction in the crystal, and to determine an effective threshold energy of 22 eV. The model of the displacement-energy profile is justified in a simple manner from crystallographic considerations. (auth)

6621 RADIATION-INDUCED PHASE TRANSITION IN $KNbO_3$. Schenk, M. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Phys. Status Solidi; 36: K31-2(1 Nov 1969). (In German).

The irradiation of a $KNbO_3$ crystal with perovskite structure was carried out in the Rossendorfer Research Reactor at 80°C and fast-neutron doses of 1.2×10^{18} to 1.9×10^{19} n/cm². X-ray photography and differential thermal analysis (DTA) were used. At the dose of 1.9×10^{19} n/cm², the room-temperature phase was transformed into the cubic high-temperature phase. With increasing dose, the intensity of the DTA peaks decreases, disappearing at 1.9×10^{18} n/cm². An anneal for 1 hr at 1000°C gives a retransformation into the room-temperature phase. (D.L.C.)

6622 INVESTIGATION OF THE BLEACHING OF NaCl SINGLE-CRYSTAL SAMPLES IRRADIATED WITH NEUTRONS. Bogusz, W. (Technical Univ., Warsaw); Sosnowski, J. Acta Phys. Pol.; 36: 773-81(Nov 1969).

Optical bleaching (with white light) of natural rock salt samples irradiated in a reactor is studied. Absorption bands of F, R, M, N_1, and N_2-centers were found for wavelengths between 3300 and 12000 Å at room temperature. The dependence of the bleaching kinetics of the particular bands on neutron doses as well as on plastic deformation is also studied. In the initial bleaching stage, the F and N_1 centers exhibit characteristic similar features. An attempt is made to explain the bleaching processes and the optical bleaching processes are compared with the damping of ultrasonic waves. (auth)

6623 ELECTRON PARAMAGNETIC RESONANCE IN ION-IMPLANTED SILICON. Daly, D. F. (Bell Telephone Labs., Whippany, N. J.); Pickar, K. A. Appl. Phys. Lett.; 15: 267-9(15 Oct 1969).

Electron paramagnetic resonance spectra of radiation damage centers in silicon were observed following implantation with nitrogen and phosphorous ions. Two of these spectra have narrow lines and can be fitted to anisotropic g tensors and zero-field splitting tensors. One is a new spectrum with approximately [111] axial symmetry and will be called the Si-B2 spectrum. The other can be identified as the Si-P3 spectrum which has been known previously to result from neutron irradiation. Both spectra are attributed to defects in the crystal containing broken silicon bonds. (auth)

6624 AN AUTORADIOGRAPHIC TECHNIQUE FOR OBSERVING CHANNELED PENETRATION OF LOW-ENERGY IONS. Jech, Cestmir (McMaster Univ., Hamilton, Ont.). Appl. Phys. Lett.; 15: 248-50(15 Oct 1969).

A method is described for recording channeling patterns by autoradiographic display of the distribution of the deeply penetrating fraction of ^{85}Kr ions injected into Si single-crystal surfaces at various angles with respect to the channeling direction. Using this method, channeling widths were measured for the penetration of low-energy (3 to 10 keV) Kr ions into Si and compared with predicted critical channeling widths. (auth)

6625 RADIATION-ENHANCED DIFFUSION OF BORON IN SILICON. Nelson, Daniel G.; Gibbons, James F.; Johnson, William S. (Stanford Electronics Lab., Calif.). Appl. Phys. Lett.; 15: 246-8(15 Oct 1969).

Boron was predeposited in silicon substrates by conventional diffusion techniques and then redistributed by bombarding the substrates with 10- and 50-keV protons. The substrates were held at a fixed temperature in the range 500 to 700°C for the duration of the bombardment. The resulting impurity profiles were determined. The low-energy impurity profiles are characterized by very abrupt junctions while the high-energy impurity profiles are characterized by long tails. No variation of either the 10- or 50-keV impurity profiles with temperature was seen over the range given above. (auth)

6626 ELECTRON PARAMAGNETIC RESONANCE STUDY OF NIOBIUM-DOPED CALCIUM MOLYBDATE. Breslow, Richard Alan. Storrs, Conn.; Univ. of Connecticut (1969). 145p.

Thesis.

Nb-doped $CaMoO_4$ single crystals were irradiated from 5 to 30 minutes with ^{60}Co gamma rays at 77°K. The gamma rays caused the normally nonparamagnetic system to become paramagnetic; after irradiation three paramagnetic species were observed, two of which had previously been observed in γ-irradiated calcium tungstate and calcium molybdate. One of these paramagnetic species was attributed to a two-center defect, this being a hole shared by two oxygen ions from neighboring tungstate tetrahedra in calcium tungstate or molybdate tetrahedra in calcium molybdate. In the present work, the third paramagnetic species is attributed to the niobium impurity ions. The major EPR spectra showed an $S = \frac{1}{2}$ defect with a 10-line hyperfine structure for each of the 4 equally probable orientations of the paramagnetic defect axes. When observed along the crystal c-axis, the lines coalesced into a single group of 10 lines and in the a-b plane into 2 groups of 10 lines. The symmetry of the g ellipsoid as determined from the angular variation bears a relationship to the crystal symmetry and suggests that Nb is substitutional for Mo and that the 4 groups correspond to an interaction related to the 4 surrounding oxygen sites. A partially resolved 6-line superhyperfine structure appeared on the major resonances with the intensity expected for overlapping ^{95}Mo and ^{97}Mo hyperfine interactions. Smaller lines arising from forbidden transitions were also observed. The spectra were fit by computer to a rhombic spin Hamiltonian with parameters: $g_{xx} = 2.006 \pm .002$, $g_{yy} = 2.011 \pm .002$, $g_{zz} = 2.053 \pm .002$, $|A_{xx}| = 23.3 \pm 1.5$G, $|A_{yy}| = 30.6 \pm 1.5$G, $|A_{zz}| = 30.4 + 1.5$G, $|Q'| = .37 + .10$G and $|Q''| < 10^{-4}$G. The direction of the largest positive g shift was found to lie approximately along an Nb-O bond direction. The model proposed for the observed paramagnetic defect is a hole which is mainly localized on an oxygen ion in the niobium-oxygen complex and partially localized on an oxygen ion in a neighboring molybdenum complex. (Diss. Abstr.)

6627 PRODUCTION AND RECOVERY OF ELECTRON RADIATION DAMAGE IN ALUMINUM. Simpson, Hoyle Mitchel. Clemson, S. C.; Clemson Univ. (1968). 101p.

Thesis.

The energy dependence of the production and recovery of Frenkel pairs produced by electron radiation damage of aluminum was investigated. The radioinduced defects were detected by changes in the electrical resistivity of the samples. After an irradiation of the samples at less than 10°K, an isochronal recovery curve was obtained for the temperature interval 15 to 51°K. Damage rates were studied for very low irradiation energies. Part of these results are in agreement with prior work for the energy range from 0.20 to 0.40 MeV. For irradiation energies below 0.20 MeV, it was necessary to average explicitly the theoretical cross section over both the sample thickness and energy distribution of the bombarding electrons. The results of this analysis indicate that the threshold energy is 16 eV which is in agreement with published values. This analysis did not reveal an appreciable amount of subthreshold damage. However, the energy dependence of stage I recovery for low irradiations indicates that some subthreshold damage is produced in aluminum. Due to the lack of fine structure in the recovery spectrum of stage I, it is assumed that the I_D and I_E substages can be accounted for by the free diffusion of interstitials. An investigation of the dose dependence of stage I recovery was made after the samples were irradiated with 0.40-MeV electrons. Two samples were mounted on the same sample holder so that both samples received an identical isochronal annealing treatment. However, the use of a shutter permitted varying the irradiation dose; thus a high-dose sample had a resistivity change of about five times that of a low-dose sample. This study of dose dependence are that substage I_E recovers at a lower temperature and the fractional amount of I_E increases as the dose increases. An analysis of the I_E data in terms of Waite's theory of random recovery gives a value for the capture radius of 3.5 lattice constants. (TSS) (Diss. Abstr.)

6628 EFFECT OF SMALL DOSES OF NEUTRON IRRADIATION ON THE RANGE OF THE LEADING DISLOCATIONS OF A STAR OF ETCH FIGURES IN ALKALI HALIDE CRYSTALS. Gusev, E. B.; Berman, I. B.; Shaskol'skaya, M. P. (Moscow Inst. of Steels and Alloys). Sov. Phys.-Cryst. (Engl. Transl.); 14: 117-18(Jul-Aug 1969).

Translated from Kristallografiya; 14: 139-40(Jan-Feb 1969).

The effects of small neutron doses (10^4 to 10^9 n/cm²) on the range of the leading dislocations of etch-figure stars in KI, KBr, KCl, NaCl, and LiF crystals were studied. For KCl and KBr crystals, the irradiated/unirradiated ratio of the length of the arm of an etch-figure star increases with dose. The softening effect of irradiation is weaker in NaCl and LiF crystals. The relaxation of irradiated crystals depends on dose and lattice energy. (D.L.C.)

6629 POSITIVE CHARGE LIBERATED FROM A SILICON CRYSTAL UNDER BOMBARDMENT BY HEAVY IONS. van Wijngaarden, A. (Univ. of Windsor, Ont.); Miremadi, B.; Finney, N. M. A.; Bradford, J. N. Phys. Rev., 185: 490-3(Sept. 10, 1969).

The orientational dependence of the yield of the positive charge liberated from the (111) surface of a silicon crystal under ion bombardment was measured. Ion beams of ^1H, ^4He, ^{14}N, and ^{40}Ar of keV energies were used. Strong minima in the yield were observed when the ion beam entered the crystal along ⟨110⟩ directions. The observed angular halfwidths exhibit an energy dependence characteristic of the transition region between the Lindhard high- and low-energy approximations. H and He projectiles show

an energy dependence more closely described by the high-energy (unscreened) approximation. (auth)

6630 PRODUCTION AND ANNEALING OF LATTICE DISORDER IN SILICON BY 200-keV BORON IONS. Westmoreland, J. E. (California Inst. of Tech., Pasadena); Mayer, J. W.; Eisen, F. H.; Welch, B. Appl. Phys. Lett.; 15: 308-10(1 Nov 1969).

The lattice disorder produced in Si by 200-keV B implantations was investigated using the standard channeling technique. The disorder production was found to be strongly temperature-dependent from about −65°C to room temperature. The annealing of the residual disorder present after such a B implantation takes place at higher temperatures. Results indicate that the nature of the lattice disorder produced in Si by low-dose ion implantation depends on the mass of the ion implanted. (auth)

6631 UNIDIRECTIONAL CHANNELING AND BLOCKING: A NEW TECHNIQUE FOR DEFECT STUDIES. Feldman, L. C. (Bell Telephone Labs., Murray Hill, N. J.); Appleton, B. R. Appl. Phys. Lett.; 15: 305-7(1 Nov 1969).

Measurements are reported of a new type of double-alignment channeling process which simultaneously uses the "channeling effect" and "blocking effect" in a relatively simple geometry. Results for the case of 500-keV He ions impinging on ZnO single crystals are shown to be in fair agreement with a calculation of the magnitude of this effect based on the Linhard model of particle channeling. It is shown that the sensitivity of this measurement to the detection of atoms not on normal lattice sites is a factor of 10 to 50 greater than in the usual channeling experiment. (auth)

6632 ISOCHRONAL ANNEALING OF p AND n-TYPE SILICON IRRADIATED AT 80°K. Clark, C. D.; Fernandez, A.; Thompson, D. A. (Univ. of Reading, Eng.). Phil. Mag.; 20: 951-64(Nov 1969).

Hall effect and electrical resistivity measurements are reported following isochronal annealing in the range 90°K to 700°K for silicon doped with boron or phosphorus. Results are presented for samples irradiated at 80°K with either 2 MeV electrons or reactor neutrons. A strong dependence of the annealing spectra on the type of irradiating particle is noted. Comparison of the results with EPR and other data from the literature allows an identification of many of the annealing stages observed. The energy level of the neutral vacancy in silicon is concluded to be very close to the valence band edge. Activation energies and orders of reaction of a number of well-resolved annealing stages are discussed. (auth) (UK)

6633 ELECTRON RADIATION DAMAGE IN A HIGH VOLTAGE ELECTRON MICROSCOPE. Ipohorski, M.; Spring, M. S. (Cavendish Lab., Cambridge, Eng.). Phil. Mag.; 20: 937-42 (Nov 1969).

The factors affecting the nucleation and growth of electron displacement damage in copper were investigated in a high-voltage electron microscope. Under certain conditions large faulted loops (~1 μ) could be obtained. The contrast of the fault fringes enabled them to be identified as interstitial in character. The first observation of the unfaulting reaction for extrinsic loops is reported. (auth) (UK)

6634 MEASUREMENTS AND CALCULATIONS OF CRITICAL ANGLES FOR PLANAR CHANNELING. Picraux, S. T. (California Inst. of Tech., Pasadena); Andersen, J. U. Phys. Rev.; 186: 267-72(10 Oct 1969).

The backscattering yields as a function of crystal orientation for planar channeling were measured for 250-keV to 2-MeV protons and He ions in silicon, and 1-MeV He ions in Ge and GaP. The angular distributions were calculated using an average-potential model. Comparison between measured and calculated critical angles $\psi_{\frac{1}{2}}$ for the {110}, {100}, and {112} planes in silicon shows that it is necessary to include the effects of surface transmission to account for the observed dependence of $\psi_{\frac{1}{2}}$ on planar spacing. A few typical measured angular distributions are compared to the calculated results. The angular widths are in fair agreement with the slightly smaller experimental values. The calculated minimum yield is significantly lower and the shoulder regions are higher and narrower than measured experimentally. Possible reasons for these discrepancies are discussed. (auth)

6635 OPTICAL ABSORPTION AND LUMINESCENCE OF IRRADIATED MgF_2. Facey, O. E.; Sibley, W. A. (Oak Ridge National Lab., Tenn.). Phys. Rev.; 186: 926-32(15 Oct 1969).

A study of the temperature and polarization dependence of the absorption and luminescence from electron and neutron-irradiated MgF_2 crystals has been made. The absorption band at 260 nm is accepted as due to an F center, and excitation, when other centers are absent, produces an emission at about 430 nm. Two other absorption bands at 370 and 400 nm arise from different types of M centers, and the data suggest that these centers give rise to emission bands at 420 and 600 nm, respectively. Several narrow absorption lines are observed in both electron- and neutron-irradiated samples. From polarization studies and optical bleaching treatment, the lines at 387.2, 385.7, 384.5, 382.3, and 380.8 nm are identified as zero-phonon and phonon-assisted transitions of the defect responsible for the 370-nm band. A comparison is made between the vibrational energies associated with the phonon-assisted lines and the dispersion relationships called for MgF_2. (auth)

6636 RADIATION DAMAGE IN SINGLE CRYSTALS OF SILICON PRODUCED BY BOMBARDMENT WITH Ne^+ AND P^+ IONS. Johansen, A.; Olsen, J. S.; Steenstrup, S.; Koch, J. (Univ. of Copenhagen). Radiat. Eff.; 2: 19-21(Nov 1969).

Single crystals of silicon were bombarded in channeling and random directions by 66- to 70-keV ions of neon and phosphorous The resulting radiation damage has been studied as a function of dose up to $\sim 10^{16}$ ions/cm^2 by successively measuring the dip in x-ray yields that occurs when protons are injected into the ⟨110⟩ channel. (auth)

6637 RELATION OF NEUTRON TO ION DAMAGE ANNEALING IN Si AND Ge. Vook, F. L.; Stein, H. J. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Eff.; 2: 23-30(Nov 1969).

Structural measurements of neutron- and ion-damage annealing in Si and Ge are compared and interpreted in terms of the annealing of identified defects. Either or both of two prominent isochronal annealing stages above room temperature in neutron irradiated Si are exhibited by x-ray, electron microscope, infrared, and electrical measurements. It is shown that the same two annealing stages are observed in Rutherford scattering measurements of ion-implanted Si. Two similar prominent annealing stages are also observed for structural measurements of neutron- and ion-irradiated Ge. For both Ge and Si, the center temperatures for the two annealing stages are approximately 0.35 and 0.5 times the melting temperature. The annealing kinetics and activation energies for the lower temperature stage in Si are correlated with the kinetics and activation energies obtained by analyzing previously reported results on the effects of the substrate temperature and the ion irradiation rate. From a comparison of the time and temperature dependences of the annealing of electron, neutron, and ion damage in Si, it is concluded that the lower temperature isochronal annealing stage near 200°C and the annealing that governs the dose-rate dependence of the crystalline-to-amorphous transition is a consequence of the annealing of divacancies. Support for this conclusion is given by recent infrared measurements of the annealing of ion-produced divacancies in Si. The high-temperature stage is shown to be near the temperature observed for the epitaxial growth of Si on Si crystal substrates and is interpreted to be related to the annealing of amorphous Si. (auth)

6638 THEORY OF RECOIL IMPLANTATION. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 2: 47-50(Nov 1969).

The basic physical principles underlying the technique of recoil implantation are discussed in some detail. The number of recoils as a function of recoil energy passing from an evaporated layer into the substrate is calculated for a particular case, and the final penetration distribution within the substrate is compared with that expected for a direct implantation. The number and distribution of unwanted contaminant impurities which inevitably recoil into the substrate during direct implantation through an oxide layer, is also discussed. (auth)

6639 ON THE ANNIHILATION OF FRENKEL DEFECT BY LOW ENERGETIC ATOMIC COLLISIONS. Drittler, K.; Lahann, H. J.; Wollenberger, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger. Kernforschungsanlage, Juelich, Ger.). Radiat. Eff.; 2: 51-6 (Nov 1969).

Frenkel defect annihilation induced by subthreshold irradiation was studied by simulating low-energy atomic collisions in the neighborhood of a Frenkel defect in computer model calculations. The fcc model crystal contained 446 atoms. The interaction between the atoms was described by a pairwise interaction Morse potential. The [100] split interstitial configuration was found to be stable and surrounded by 62 lattice sites at which a vacancy recombines spontaneously with the interstitial. For at least another 24 lattice sites it was shown that the Frenkel defect recombines if a kinetic energy of 0.1 eV is transferred to one of the atoms of the interstitial configuration or to certain atoms in the neighborhood of the defect. A few recombination processes are discussed in

detail. The number of the above mentioned lattice sites is compared with experimental data. (auth)

Physical Properties

Refer also to abstracts 6189, 6192, 6202, 6204, 6258, 6280, and 6344.

6640 (CEA-R-3849) CONFIGURATION AND MIGRATION OF POINT DEFECTS IN ALKALI METALS. Torrens, Ian M.; Gerl, Maurice (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1969. 24p. (In French). Dep. CFSTI (U. S. Sales Only).

A computer calculation of vacancy and interstitial migration using a pair-interaction potential deduced from the theory of pseudopotentials is described. The parameters involved in the expression of the potential are adjusted so as to reproduce the elastic constants and the phonon spectrum of the perfect crystal. One obtains the relaxation energies at equilibrium configuration and at the saddle point and the migration energy of a vacancy and an interstitial in the alkali metals. For Na, K, and Rb, the vacancy mechanism is the most probable whereas in Li, there is a possibility of an interstitial mechanism, which would explain the experimental results. The diffusion of alkali solutes in alkali metals is analyzed by means of a pair-interaction potential deduced from the physical properties of the pure solvent and solute crystals. For solute atoms bigger than the solvent, the substitutional mechanism explains the experimental results whereas an interstitial mechanism is more probable for small impurities. This phenomenon may explain the experimental results observed for the diffusion of Na in K and K in Na. The ΔQ values are given for several combinations of the four alkali metals Li, Na, K, and Rb. (auth)

6641 EMISSION AND ADSORPTION PROPERTIES OF GADOLINIUM AND YTTRIUM FILMS ON A TUNGSTEN SINGLE CRYSTAL. Gorbatyi, N. A.; Karpachev, B. I. (Tashkent State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 11: 1144-6(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1406-9(May 1969).

The behavior of Gd and Y films on a microscopic W crystal in a field-emission microscope with a vibrating point was studied. The films were sputtered under migration equilibrium conditions, and the emission and work functions were measured. The maximum, minimum, and "shelf" of the work function curve are tabulated. The field-emission images are described. The heat of vaporization was determined to be 5.1 and 5.2 eV for Gd and Y, respectively, from W, and the sequence of emission patterns was the reverse of that in the sputtering. (D.L.C.)

6642 CONDUCTION MECHANISM IN VANADIUM PENTOXIDE. Volzhenskii, D. S.; Pashkovskii, M. V. (Lvov State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 11: 950-3(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1168-72(May 1969).

The temperature dependences of the electrical conductivity and thermoelectric power were determined, in the 77 to 450°K range, along three crystallographic directions in V_2O_5 single crystals grown under oxygen pressures (5 atm). The anisotropy of the electric conductivity increased when the concentration of oxygen in the melt was increased. The temperature dependence of the electrical conductivity had two inflections: one at 250°K and the other at 390°K. The activation energy was different for different crystallographic directions. The thermoelectric power was negative at all temperatures and it had a maximum (for all three crystallographic axes) at a temperature of ~250°K. The experimental values of the thermoelectric power and electrical conductivity were used to determine the position of the Fermi level and to calculate the density and mobility of carriers. Beginning from 350 to 390°K, the mobility increased exponentially with temperature. It was found that the thermoelectric power at 400°K was described by Morin's equation for small-radius polarons. (auth)

6643 ELECTRICAL TRANSPORT PROPERTIES IN THE PSEUDOBINARY SYSTEM NbO_2–VO_2. Kristensen, I. K. (Technical Research, Danfoss, Denmark). J. Appl. Phys.; 40: 4992-4(Nov 1969).

Measurements were made on the electric conductivity, thermoelectric power, and Hall effect of NbO_2 solid-solution mixtures with up to 6 mole % VO_2. The overlap integral and parameters in the equation for the drift mobility of small polarons are evaluated, and it is concluded that the mixtures represent a transition into the region of small nonadiabatic polarons. (D.L.C.)

6644 NATURE OF THE FINE STRUCTURE OF THE ELASTIC ELECTRON-REFLECTION CURVES IN THE MODERATE ENERGY RANGE. Shul'man, A. R.; Korablev, V. V.; Morozov, Yu. A. (Leningrad Polytechnical Inst.). Sov. Phys.-Solid State (Engl. Transl.); 11: 1003-5(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1236-8(May 1969).

An experimental study was made of the elastic electron-reflection coefficient R of silicon and molybdenum single crystals in the primary-electron energy range $E_p = 50$ to 1000 eV. The R (E_p) curves were found to have a series of fine-structure maxima and minima which can be explained by the Bragg reflection (the values of the energy E_p at which the maxima were observed were related linearly to the square of the order of electron reflection). When the temperature of a sample was increased, the fine structure was destroyed by the thermal vibrations of the crystal lattice atoms. Variation of the angle of incidence of the primary beam on the surface of a crystal altered the fine structure, indicating that this structure was related to the orientation of the electron beam with respect to the crystallographic directions. (auth)

6645 WORK FUNCTION OF ULTRAHIGH-VACUUM-DEPOSITED BERYLLIUM FILMS. Dixon, R. D.; Lott, L. A. (Dow Chemical Co., Golden, Colo.). J. Appl. Phys.; 40: 4938-9(Nov 1969).

The work function of ultrahigh-vacuum-deposited beryllium films was measured to be 5.08 ± 0.08 eV. Upon exposure of freshly deposited films to pure oxygen at pressures of 5×10^{-7} torr, the work function was observed to decrease rapidly to a stable value of 3.60 ± 0.05 eV. (auth)

6646 EXPERIMENTAL INVESTIGATION OF DIFFUSION OF DOPANTS ALONG DISLOCATIONS INTRODUCED INTO SILICON BY ELECTRON BEAM HEATING. Dudko, G. V.; Kolegaev, M. A.; Panteleev, V. A. (Gorky State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 11: 1097-1100(Nov 1969).

Translated from Fiz. Tverd. Tela; 11: 1356-9(May 1969).

High dislocation densities were introduced into silicon wafers by local electron beam heating, after which dopants were diffused into the wafers. The diffusion was studied both by the radioactive isotope technique and by a p–n junction technique. A photograph is presented of a specimen with p–n junctions formed by diffusion of a dopant into dislocated and unperturbed regions of a silicon crystal; the parameters for diffusion of phosphorus, antimony, boron, and aluminum along dislocations are also presented. (auth)

6647 MAGNETIC ANISOTROPY IN DYSPROSIUM. Bly, P. H. (Simon Fraser Univ., Burnaby, British Columbia); Corner, W. D.; Taylor, K. N. R. J. Appl. Phys.; 40: 4787-90(Nov 1969).

Torque measurements were made on single-crystal dysprosium. The constant K_1 was determined in the paramagnetic region, and also in the antiferromagnetic region, where the transition to ferromagnetism appeared as a large distortion in the torque curves. From the data in the paramagnetic region, the saturation value of K_1 is predicted as 1.1×10^8 ergs g^{-1}. The constant K_4 was determined in the ferromagnetic region, and changes in sign were observed at field strengths close to the critical value. The changes in easy direction for magnetization are compared with the behavior of the magnetostriction of dysprosium. (auth)

6648 KONDO EFFECT IN SINGLE CRYSTALS OF Y–Ce ALLOYS. Yoshida, S.; Sugawara, T. (Tokyo Univ.). Phys. Lett.; 30A: 422-3(1 Dec 1969).

Evidence for the coexistence of the crystal field splitting and the Kondo effect was found in single crystals of Y–Ce. Results of magnetic susceptibility measurements are reported. (auth)

6649 INFLUENCE OF DISLOCATION SUBSTRUCTURES ON DISLOCATION RELAXATION IN MOLYBDENUM SINGLE CRYSTALS. Muehlbach, H. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Phys. Status Solidi; 36: K33-6(1 Nov 1969).

Molybdenum single crystals were deformed by cold rolling at room temperature and specimens with {100}⟨110⟩ and {110}⟨100⟩ orientations investigated after 30 and 10% reductions. Modulus and damping measurements were carried out after 30-min anneals at temperatures up to 1000°C. The results are expressed as damping Q^{-1}, oscillation period f^{-1}, and "modulus defect" $(f^{-1}-f_0^{-1})/f_0^{-1}$, plotted versus annealing temperature. Possible reasons (dislocation substructure and internal stresses) for the increasing peak height and modulus defect above 300°C. (D.L.C.)

6650 X-RAY DETERMINATION OF THE DEBYE TEMPERATURE OF URANIUM MONOCARBIDE. Colella, R.; Dragone, D.; Merlini, A. (CCR-EURATOM, Ispra, Italy). Phys. Status Solidi; 36: 135-42(1 Nov 1969).

Bragg reflections by single crystals of UC, cleaved along (100) planes, were found to have negligible extinction for values of $\sin\theta/\lambda$ in the range from 0.4 to 1.2 A^{-1}. The integrated intensities of these reflections were measured by using MoKα radiation at various temperatures from 77 to 773°K. Plots of the logarithm of the integrated intensities vs temperature, or vs $(\sin\theta/\lambda)^2$ at a

fixed temperature, were straight lines. The slopes of the plotted lines yielded an average value $\theta_M = (265 \pm 5)$ °K for the Debye temperature defined in terms of the uranium atoms only, and $\theta_M = (366 \pm 7)$ °K, using the average of the U and C masses in the Debye–Waller factor. These values are compared with those determined by different experimental techniques. (auth)

6651 MAGNETIC SUSCEPTIBILITY AND ENERGY BAND STRUCTURE OF ZIRCONIUM MONOCARBIDE. Borukhovich, A. S.; Dubrovskaya, L. B.; Matveenko, I. I.; Geld, P. V. (Inst. of Chemistry, Sverdlovsk, USSR). Phys. Status Solidi; 36: 97-102 (1 Nov 1969).

The magnetic susceptibility of zirconium monocarbide has been studied as a function of temperature and concentration in the homogeneity region $0.58 \leq x \leq 1.0$ and at temperatures from 20 to 1300°K. It is shown that the temperature dependence $\chi(T)$ of all the samples may be described by the equations

$$\chi = \begin{cases} \text{const at } T < 290°K, \\ \chi_0 + \alpha T \text{ at } T > 290°K. \end{cases}$$

The obtained results are discussed in terms of concepts available on the electronic structure of the cubic carbides of the group IVa and Va transition metals. A "flat" minimum was found in the curve N(E) lying near stoichiometric composition of the monocarbides. (auth)

6652 MAGNETIC SUSCEPTIBILITY OF Ce AND Pr IN SrB_6 AND YB_6. Fisk, Z. (Univ. of California, San Diego, La Jolla). Phys. Lett., 30A: 152-3(Oct. 6, 1969).

Magnetic susceptibility data suggest that the crystal-field splittings of the 4f levels of Ce and Pr impurities are larger in metallic YB_6 than in isostructural and semiconducting SrB_6, contrary to what might be expected. (auth)

6653 MAGNETOTHERMAL OSCILLATIONS AND THE FERMI SURFACE OF ReO_3. Graebner, J. E.; Greiner, E. S. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 185: 992-4(Sept. 15, 1969).

Magnetothermal oscillations have been observed in single crystals of ReO_3. The three sets of frequencies observed are in good agreement with Mattheiss's augmented-plane-wave calculations, which include open orbits along ⟨100⟩ directions. (auth)

6654 MAGNETIC FORM FACTOR OF THULIUM METAL. Brun, T. O. (Ames Lab., Iowa); Lander, G. H. Phys. Rev. Lett.; 23: 1295-8(1 Dec 1969).

The magnetic form factor of thulium at 4.2°K has been measured with polarized neutrons. With the exception of the two innermost reflections, the form factor is in excellent agreement with the theoretical $4f^{12}$ form factor. At low angles an additional contribution to the form factor is present. We have interpreted this as 5d-like conduction-electron polarization, although the magnitude is unexpectedly large. (auth)

6655 POLARIZED-NEUTRON-DIFFRACTION STUDY OF MAGNETIC MOMENTS IN YTTRIUM–COBALT ALLOYS. Kren, E.; Schweizer, J.; Tasset, F. (CEN, Grenoble, France). Phys. Rev.; 186: 479-83(10 Oct 1969).

The magnetic moments in the ordered YCo_5, Y_2Co_7, and YCo_3 intermetallic compounds with closely related crystal structures have been investigated on single crystals using the polarized-neutron-diffraction technique. By assuming that only the cobalt atoms have magnetic moments and using Moon's experimental cobalt form factor extrapolated smoothly to unity, a discrepancy was found between the measured and calculated magnetic-structure factors. This can be explained by the existence of either a magnetic moment at the yttrium sites coupled antiparallel to the cobalt moments, or a diffuse negative-spin polarization. The ferromagnetically aligned magnetic moments on the cobalt atoms are influenced by the yttrium neighbors; they are the smallest in YCo_5, which is the richest in yttrium, and in all cases are the smallest at the sites having the most yttrium neighbors. (auth)

6656 HIGH-FIELD MAGNETIZATION OF THULIUM SINGLE CRYSTALS. Richards, D. B.; Legvold, S. (Ames Lab., Iowa). Phys. Rev.; 186: 508-14(10 Oct 1969).

The magnetization of thulium was measured along the ⟨10$\bar{1}$0⟩ (b axis) and ⟨0001⟩ (c axis) directions from 4.2 to 300°K in magnetic fields up to 100 kOe. The measurements were taken using a vibrating-sample magnetometer designed and constructed to operate in a 100-kOe superconducting solenoid. The data indicate a Néel temperature of 58°K with large anisotropy favoring the c axis. They suggest that the antiferromagnetic structure below 58°K is an axial structure oriented along the c axis. The low-field isofields for the c axis show that at about 42°K the antiferromagnetic structure begins to square up, and at about 25°K the moments assume a ferrimagnetic structure with a net moment along the c axis at 4.2°K of 1.0 μ_B per atom. The ferrimagnetic coupling can be overcome by magnetic fields above 28 kOe, yielding a ferromagnetic structure with a saturation magnetization of 7.14 μ_B per atom. The b-axis sample, however, remained magnetically hard to the highest fields used; at 4.2°K the moment reached 0.75 μ_B per atom at 93 kOe. The data in the paramagnetic region gave a value for μ_{eff} of 7.61 μ_B, with paramagnetic Curie temperatures of $\theta_{11} = 41$°K, and $\theta_{\perp} = -17$°K, where θ_{11} is for fields applied along the c axis and $\theta_{\perp}$ is for fields applied perpendicularly to the c axis. (auth)

6657 MAGNETOACOUSTIC EFFECTS IN VERY PURE Cd. Gavenda, J. D.; Chang, F. H. S. (Univ. of Texas, Austin). Phys. Rev.; 186: 630-41(15 Oct 1969).

Ultrasonic attenuation as a function of magnetic field intensity has been measured in very pure Cd at liquid-helium temperatures. The results are related to the dimensions of the Fermi surface using the usual phenomenological model for the magnetoacoustic effect. New resonances are observed, and an explanation in terms of cylindrical sections of the Fermi surface is offered. Finally, evidence for acoustic cyclotron resonance is presented, along with comments on the observation and interpretation of such phenomena. (auth)

6658 EMPIRICAL CORRELATION BETWEEN IMPURITY-DEPENDENT AND SIZE-DEPENDENT DEVIATIONS FROM MATTHIESSEN'S RULE IN INDIUM. Neighbor, J. E. (Northeastern Univ., Boston); Newbower, R. S. Phys. Rev.; 186: 649-50(15 Oct 1969).

A study of published measurements on indium wires at liquid-helium temperatures indicates that the effects of boundary scattering and impurity scattering on the temperature dependence of electrical resistivity are equal, for equal values of $\rho_{0°K}$. This simple relation, and similar relations which may hold for other metals, appear to have important implications for proposed explanations of deviations from Matthiessen's rule. (auth)

6659 EFFECT OF VACANCY FORMATION ON THE TEMPERATURE DEPENDENCE OF THE POSITRON LIFETIME. Bergersen, B. (Inst. of Theoretical Physics, Goteborg); Scott, M. J. Solid State Commun., 7: 1203-5(Sept. 1969).

A simple model is constructed for the trapping of positrons by vacancies in metals. It is shown that this model can explain the dramatic temperature dependence of the positron mean lifetime in certain metals. The model predicts a double lifetime. It is argued that this effect should be measurable. Estimates of the vacancy formation energy were made for In, Cd, Zn, and Al, and in the three latter cases qualitative agreement was found with values obtained by other methods. (auth) (UK)

6660 INFLUENCE OF ULTRASONIC AGITATION ON THE ELECTRICAL BEHAVIOR OF ION IMPLANTED SILICON. Johansson, N. G. E.; Mayer, J. W. (California Inst. of Tech., Pasadena). Contract F61052-68-C-0062. Radiat. Eff.; 2: 61-2(Nov 1969).

In a study of the anneal behavior of Si implanted with Ga, In, and Sb, ultrasonic agitation before the anneal was found to have a marked effect on the Hall effect and sheet resistivity measurements, especially at low anneal temperatures. Ultrasonic agitation after annealing at 650 and 900°C did not produce this effect. It is believed that this effect is due to annealing of defect centers. (D.L.C.)

6661 PLANE-WAVE SOUND RADIATION FROM MOBILE DISLOCATION WALLS. Schwenker, Robert Otto Urbana, Ill.; Univ. of Illinois (1969). 138p.

Thesis.

Macroscopic re-radiated plane waves from microscopic dislocation sources oscillating in a narrow slip band have been produced and detected in LiF and NaCl crystals in the 10- to 100-MHz range. The observed waves were shown to depend upon the dislocation motion through their dependence on the orientation of the exciting waves and their dependence on the number of pinning points on the dislocation lines during γ irradiation of LiF and NaCl and during recovery of NaCl. The quantitative values of the re-radiated wave amplitudes were shown to be in good agreement with the values given by the model of the vibrating string for the dislocation displacements, both in the low-frequency or frequency-independent region and in the high-frequency or ω^{-1} frequency region of the displacement. Since the measured re-radiated amplitudes were as large as is permitted by the vibrating string model, dislocation–dislocation interactions could not play an important role in limiting the dislocation motion for this configuration of dislocations. While the energy losses and, hence, the scattering cross sections for direct re-radiation scattering of waves were small compared to the energy losses and cross sections due to indirect (viscous) scat-

tering of thermal waves by the moving dislocations for finite wall widths, it was seen that direct scattering losses per dislocation would not be negligible in this frequency range for very thin walls of dislocations where all the dislocations radiate waves which are in phase with each other or at low temperatures where the viscous damping is small. (Disser. Abstr.)

Moessbauer Effects and NMR

Refer also to abstract 5949.

6662 (ORO-3603-4) A. THE HYDROGEN FLUORIDE SOLVENT SYSTEM. B. MOESSBAUER STUDIES ON RARE EARTH COMPOUNDS. Third Annual Report. Clifford, A. F. (Virginia Polytechnic Inst., Blacksburg. Dept. of Chemistry). Aug. 1969. Contract AT(40-1)-3603. 42p. Dep. CFSTI.

A number of europium compounds were investigated by ^{151}Eu Moessbauer spectroscopy, including $Eu_2Zr_2O_7$, $Eu_2Si_2O_7$, $Eu_2Sn_2O_7$, and $EuPO_4$. The last has the smallest linewidth of any known oxy compound of europium. Incipient quadrupole splitting was found in some of the others. Correlations were made on isomer shift and ionicity, on linewidth and crystal structure, and on absorption efficiency and rigidity of crystal structure. Isotherms were investigated at a temperature of 500°C and below, and at oxygen pressures from 10^{-5} mm to an upper limit of approximately 200 mm. The PrO_x-O_2 isotherms were measured using a quartz beam microbalance, which enabled the continuous observation of small changes in the stoichiometry of the praseodymium oxide to be observed as a function of the oxygen pressure applied to the oxide. All of the isotherms exhibited stoichiometry hysteresis and, with the exception of two isotherms, hysteresis effects were observed to be between the limits of known regions of composition stability. The isotherms agreed with those previously studied; however, where there was disagreement, the discrepancies were postulated to be caused by previous errors in temperature measurement. Work has continued on the polarography of $Cu(H_2O)_2^{2+}$ in liquid HF. Work was also begun on the basicity of CH_3CN in liquid HF. (auth)

6663 MOESSBAUER EFFECT OF ^{119}Sn IN SUBSTITUTIONAL ALLOYS OF Ag AND In. Danner, Bruce Ronald. Athens, Ohio, Ohio Univ., 1968. 265p.

Thesis.

The Moessbauer effect was used to infer the atomic force constants of ^{119}Sn in two substitutional alloys of silver (7.4 at. %; 16.26 at. % Sn) and one of indium (5.71 at. % Sn). Using a standard transmission geometry in conjunction with a constant-acceleration Doppler-shift drive, measurements were made on several thicknesses of each absorber at a variety of temperatures between 77 and 155°K for In–Sn and 77 and 360°K for both Ag–Sn alloys. The Moessbauer fraction f_a in the absorbing materials was determined by use of a self-consistent technique using the linewidth and percent absorption, as well as two techniques using the area of the resulting absorption curves. Values of $f_a = 0.64$ for 7.4 at. % Ag–Sn, $f_a = 0.61$ for 16.26 at. % Ag–Sn, and $f_a = 0.20$ for In–Sn at 77°K were obtained by fitting Debye type curves of $\Theta_{Mf} = 200^{+8}_{-4}$ °K, 188 ± 8 °K, and 95 ± 3 °K, respectively, to the final Moessbauer fraction versus temperature results. The corresponding linewidth values reduced to zero thicknesses are $\Gamma(0) = 0.775$ mm/sec for 7.4 at. % Ag–Sn, $\Gamma(0) = 0.502$ mm/sec for 16.26 at. % Ag–Sn, and $\Gamma(0) = 0.518$ mm/sec for In–Sn. The significance of the different values of Θ_{Mf} in terms of changes in the force constants for the two Ag–Sn alloys which have the same isotopic impurity mass ratios is discussed. (Diss. Abstr. Int., B)

6664 CHANGE IN NUCLEAR RADIUS UPON EXCITATION FOR ^{119}Sn, ^{121}Sb, ^{125}Te, ^{127} ^{129}I, AND ^{129}Xe FROM MOESSBAUER ISOMER SHIFTS. Ruby, S. L.; Shenoy, G. K. (Argonne National Lab., Ill.). Phys. Rev.; 186: 326-31(10 Oct 1969).

The ratio $\delta\langle R^2\rangle/\langle R^2\rangle$ for two nuclei can be obtained by comparing the measured isomer shifts for isoelectronic compounds of the two elements. Such a determination is fairly insensitive to the absolute value of the electron density at the nucleus. These ratios have been found sequentially for ^{119}Sn, ^{121}Sb, ^{125}Te, $^{127,129}I$, and ^{129}Xe. Taking $\delta\langle R^2\rangle/\langle R^2\rangle$ for ^{119}Sn to be 2.4×10^{-4}, absolute values of $\delta\langle R^2\rangle/\langle R^2\rangle$ for remaining nuclei have been found. The values are -14.6×10^{-4}, 1.9×10^{-4}, -4.8×10^{-4}, 6.2×10^{-4}, and 0.55×10^{-4} for ^{121}Sb, ^{125}Te, ^{127}I, ^{129}I, and ^{129}Xe, respectively. These values overlap those obtained directly by electron-density calibrations, done individually, although they are different in some cases from earlier determination. These results also supply a consistent set of values for the isomer shift per 5p or 5s electron for all five elements. (auth)

6665 MOESSBAUER DIFFRACTION. II. DYNAMICAL THEORY OF MOESSBAUER OPTICS. Hannon, J. P. (Rice Univ., Houston, Tex.); Trammell, G. T. Phys. Rev.; 186: 306-25 (10 Oct 1969).

The dynamical theory of Moessbauer optics is developed utilizing the multiple-scattering equations derived in the preceding paper (Phys. Rev. 169: 315(1968)). The general optical equations obtained are analogous to the equations of the dynamical theory of x-ray diffraction, but are generalized to account for the very strong polarization mixing which occurs in Moessbauer optics. This polarization mixing leads to a number of interesting features, such as Faraday effects, selective absorption, and selective critical reflection. The cases of Bragg reflection, Laue transmission, critical reflection, and off-Bragg transmission are treated in detail. (auth)

Theoretical Physics

Refer also to abstracts 6697 and 6814.

6666 (SC-T-69-1057) KINETICS OF A SPARK BY THE LIGHT OF AN OPTICAL QUANTUM GENERATOR (LASER) ON THE SURFACE OF DIELECTRICS. Veduta, A. P.; Sviridenkov, E. A. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from Zh. Priki. Spektrosk.; 6: 256-7(1967). 3p. Dep. CFSTI.

A light flash was detected on the dielectric surface under irradiation by the laser light. Its kinetics was studied and different mechanisms of its excitation are discussed. (auth)

6667 QUANTUM MARKOVIAN PROCESSES WITH A DENUMERABLE SET OF STATES. Garczynski, W. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 17: 517-21(1969).

A theory of quantum Markovian processes (see also Acta Phys. Polon., 35: 479(1969)) with a denumerable set of states is outlined. This is a most general case of interest for quantum theory since any kind of quantum Markovian process can be reduced to it. (auth)

6668 ELECTRON EIGENSTATES IN UNIFORM MAGNETIC FIELDS. Rensink, Marvin E. (Univ. of California, Livermore). Amer. J. Phys., 37: 900-4(Sept. 1969).

The purpose of this paper is to show in detail how the electron energy-eigenvalue spectrum changes from the form $\epsilon_B = (N + \frac{1}{2})\hbar\omega_c + P_z^2/2M$ in a finite magnetic field to the free-particle form $\epsilon_0 = P^2/2M$ in zero magnetic field. An electron confined to a "box" of finite volume is considered and the exact eigenstates for arbitrary magnetic field strengths are calculated. When the electron cyclotron radius $r_c = (2\hbar/M\omega_c)^{\frac{1}{2}}$ is small compared to the dimensions of the box, the spectrum ϵ_B is obtained, and when it is large ϵ_0 is obtained. The key to this demonstration is a mathematical identity that relates the magnetic eigenfunctions to the free-particle eigenfunctions. Magnetic corrections to the spectrum ϵ_0 are obtained without the use of quantum mechanical perturbation theory. (auth)

6669 INVARIANTS AND THE EVOLUTION OF COHERENT STATES FOR A CHARGED PARTICLE IN A TIME-DEPENDENT MAGNETIC FIELD. Malkin, I. A.; Man'ko, V. I.; Trifonov, D. A. (Lebedev Inst. of Physics, Moscow). Phys. Lett.; 30A: 414 (1Dec 1969).

New invariants, coherent states, and the Green function are constructed for a charged particle in a time-dependent magnetic field. (auth)

6670 THERMODYNAMICS OF THE ELECTROMAGNETIC FIELD IN CONTINUOUS MATTER. Meixner, J. (Technische Hochschule, Aachen). Z. Phys.; 229: 352-64(1969). (In German).

The following questions are discussed. Does the electromagnetic field energy add to the internal energy or to the free energy? What are density of momentum and flow of energy in the presence of an electromagnetic field? How is the electromagnetic force density to be formulated in the best way? With respect to the first question, various thermostatic potentials are considered. The other questions find an answer from a relativistic formulation of the equations of motion. In particular it is shown that the various definitions of the pressure which arise from the manifold of thermostatic potentials and which lead to different expressions for the electromagnetic force density are irrelevant if, instead, one uses the gradients of the unambiguous chemical potential and of the temperature, multiplied by the entropy density, as parts of the total force density. (auth)

6671 REMARKS ON THE CONCEPTUAL FRAME OF QUANTUM PHYSICS. Haag, Rudolf (Univ., Hamburg). Z. Phys.; 229: 384-91(1969). (In German).

Idealizations which have to be made when one speaks about a physical system, its set of states, and the measurement process are discussed. Some simple models of state spaces which are more general than those appearing in quantum physics are briefly described. (auth)

6672 CRITICAL TEMPERATURE BOUNDS OF QUANTUM LATTICE GASES. Greenberg, W. (Indiana Univ., Bloomington). Commun. Math. Phys., 13: 335-44(Sept. 10, 1969).

One proves rigorous critical temperature upper bounds of quantum lattices in the infinite volume limit and with many-body potentials which conserve the number of particles. The results are obtained from the analyticity properties of the reduced correlation functionals. As an example the isotropic Heisenberg model is considered. The method also extends previous results on the analyticity and the critical temperature of a classical lattice. (auth)

6673 ON A CLASS OF EQUILIBRIUM STATES UNDER THE KUBO-MARTIN-SCHWINGER BOUNDARY CONDITION. I. FERMIONS. Rocca, F.; Sirugue, M.; Testard, D. (Univ., Aix-Marseille, France). Commun. Math. Phys., 13: 317-34 (Sept. 10, 1969).

Using the Kubo–Martin–Schwinger boundary condition for equilibrium states of quantum statistical mechanics of fermion gas, it is proven that for $T \neq 0$ a one-particle evolution (corresponding essentially to bilinear hamiltonians) generally defines a unique equilibrium state, which is quasi-free. Conversely any quasi-free state is the equilibrium state for a single one-particle evolution if it has no Fock part in its product decomposition. Limiting cases where $T \to 0$ and $T \to \infty$ are studied. In the case where $T \to 0$ one shows that the state generally converges to a Fock state linked to the evolution. (auth)

6674 BINDING ENERGIES AND WAVE FUNCTIONS OF THREE BOSONS INTERACTING THROUGH LOCAL POTENTIALS. Lovitch, L.; Rosati, S. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nuovo Cim., 63B: 355-60(Sept. 11, 1969).

Results obtained using a variational calculation are presented for the three lowest bound states of a three-identical-boson system interacting through local two-body potentials. The ground-state energy is also calculated for the best trial function of a product form. These results may be used for comparison in attempts to integrate exactly the Schrodinger equation of the system. (auth)

6675 INDUCED TRANSITIONS OF A RELATIVISTIC ELECTRON IN A CONSTANT HOMOGENEOUS MAGNETIC FIELD. Denisov, M. M. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 187: 545-8(July 21, 1969). (In Russian).

On considering the interaction of a relativistic electron with a plane, monochromatic electromagnetic wave, the wave functions of the electron are selected with a fixed spin projection on the direction of the vector of the constant field tension. In this case the formulas for the transition probabilities assume a readily interpretable form, and simple rules of selection with respect to the quantum number n are obtained. Exact expressions are chosen from the literature for normalized wave functions and energy spectrum of a relativistic electron in a constant, homogeneous magnetic field. The plane monochromatic electromagnetic wave is described classically. Expressions are then derived for the probabilities of induced, single-quantum electron transitions from an initial state to a final state. A total of six transitions are allowed. Three transitions proceed with the absorption of energy, and three transitions proceed with the emission of energy. In this case the propagation direction of the electromagnetic wave coincides with the vector direction of the magnetic field tension. Transition probabilities are also obtained for the more general case, where the electromagnetic radiation is propagated at an arbitrary angle to the direction of the vector of the tension of the constant, homogeneous magnetic field. (TTT)

6676 IMPULSE APPROXIMATION IN PERTURBED HARMONIC OSCILLATOR PROBLEM. Choi, Chul Kyu; Koh, Yoon Suk (Seoul National Univ.). New Phys. (S. Korea), Suppl.; 9: No. 1, 67-72(Nov 1969).

The impulse approximation is applied to the perturbed harmonic oscillator and compared to the Born approximation. The result is seen to agree quite well in the impulse limit. This indicates that the approximation is useful in the problem where the interaction is rapid. (auth)

6677 DERIVATION OF THE CHANGE OF STATE IN MEASUREMENT FROM THE CONCEPT OF MINIMAL MEASUREMENT. Herbut, F. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Ann. Phys. (N.Y.); 55: 271-300(Nov 1969).

The concept of the minimal measurement of a general observable A (having the spectral form $A = \Sigma_n a_n P_n$) is defined by requiring (1) that a physical system for which the measurement of A gave a_n have this eigenvalue with certainty in case of an immediate repetition of the same measurement, and (2) that the change of the quantum state (statistical operator) ρ in the measurement be minimal (under the restriction of (1)). It is pointed out that every quantum state ρ is an element of the operator Hilbert space (consisting of all operators with a finite absolute norm), and that one can express "closeness" of two quantum states properly in terms of the "distance" inherent in this space. It is shown that with the use of this distantial operator space and projector algebra, requirements (1) and (2) lead a fortiori to the general change-of-state expression: $\rho \to \rho' = \Sigma_n P_n \rho P_n$. In an endeavor to present a rather comprehensive investigation of the implications of the minimal measurement concept, two alternative equivalent definitions for it are treated in detail: that in terms of compatible observables, and that based on reduction of a wave packet. For systems satisfying a subsidiary condition $P_\rho = \rho$ (P being a given projector) the measurability condition for an observable A is derived: it is $[A, P]_- = 0$, or in stronger form $PA = A$. Subsystem measurements on composite systems are discussed. The known paradox of the quantum theory of measurement is obtained from a new angle. In summary the measurement concept is reduced simply to a projection performed in the operator Hilbert space, and the many-sidedness of the former is explained in terms of the versatility of the latter. In order to give requirement (1) a suitable mathematical form (which is $\rho' = \Sigma_n P_n \rho' P_n$ or equivalently $[\rho', A]_- = 0$), the auxiliary problem of possible relations between a quantum state ρ and an observable A is systematically investigated. The case of compatibility ($[\rho, A]_- = 0$) and that of incompatibility ($[\rho, A]_- \neq 0$) are discussed. It is shown that the former, in contrast to the latter, is characterized by the fact that the possibly nonsharp probability of distribution which ρ gives with respect to the eigenvalues a_n of A may be due to statistical mixing of subensembles ($\rho = \Sigma_i w_i \rho_i$), each ($\rho_i$) dispersion free regarding A. (auth)

6678 SHORT-RANGE CORRELATIONS AS FIRST-ORDER PERTURBATION TO THE HARTREE–FOCK METHOD. Boffi, S. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nuovo Cim., Lett., 2: 538-40(Oct. 11, 1969).

In the Hartree–Fock (H–F) method used in the many-body problem, each particle is thought to move in an average potential due to the presence of the other particles: the quite complicated many-body problem is reduced to a single-body one. However, the chance that simultaneously all the particles are in their H–F state is rather low; this fact is due to the lack of coherence between the single-particle waves, the H–F method neglecting collective features of many-body systems. In particular, two-body short-range correlations such as those producing a diffraction dip in the charge form factor of ^{4}He, cannot be reproduced by H–F wave functions. Here the possibility is suggested that such correlations are a first-order correction to the H–F method. (M.O.W.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 6746.

6679 (SLAC-Trans-105) PRELIMINARY RESULTS OF A STUDY OF THE ρ-MESON RESONANCE USING COLLIDING ELECTRON-POSITRON BEAMS. Balakin, V. E.; Budker, G. I.; Korshunov, Yu. V.; Mishnev, S. I.; Pakhtusova, E. V.; Pestov, Yu. N.; Sidorov, V. A.; Skrinskii, A. N.; Tumaikin, G. I.; Khabakhpashev, A. G. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt for Stanford Linear Accelerator Center, Calif., from Russian Preprint No. 327. 12p. Dep. CFSTI.

The results are reported of a preliminary analysis of approximately 100,000 photographs from a spark-chamber study of the ρ-meson, using the electron-positron storage ring VEPP-2. The measurements were carried out for nine energy values between 508 and 514 MeV. Two types of events were analyzed: elastic electron-positron scattering and charged kain pair production. A least-squares fit of the results to the Breit-Wigner curve yielded the following values for the resonance parameters: $\Gamma = 4.1 \pm 0.5$ MeV and $\sigma_0 = 2.3 \pm 0.3$ μb. The total resonance cross section for the formation of the ρ-meson was found to be $6p = 4.8 \pm 0.6$ μb. (L.B.S.)

6680 SYNCHROTRON RADIATION AS A LIGHT SOURCE. Godwin, R. P. (Deutsches Elektronen-Synchrotron, Hamburg). Ergeb. Exakten Naturwiss.; 51: 1-73(1969).

First, a qualitative discussion of the properties of radiation emitted by a relativistic electron is presented. The main results of the exact theory of synchrotron radiation are then summarized. The characteristics of synchrotron radiation as a light source are discussed with particular stress on the xuv region. Experimental techniques and difficulties peculiar to using synchrotron radiation in the xuv are treated. Finally a discussion of some problems which can be advantageously investigated with synchrotron radiation as a spectroscopic tool is given. (160 references) (W.H.K.)

6681 ISOTOPIC STRUCTURE OF THE PHOTOEXCITATION AMPLITUDE OF NUCLEON RESONANCES WITH ISOTOPIC SPIN 1/2. Rekalo, M. P. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 1444-8(Sept. 1969). (In Russian).

Some experiments are analyzed which are sensitive to isotopic structure of radiative decay amplitudes of the nucleon resonances with isotopic spin $\frac{1}{2}$. It is shown that the comparison of proton polarization in the reactions $\gamma + p \rightarrow p + \pi^0$ and $\gamma + n \rightarrow p + \pi^-$ gives information on the relative value of isoscalar and isovector transitions determined for all known nucleon resonances with isotopic spin $\frac{1}{2}$. Formation of nucleon resonances in πN and $\bar{K}N$-collisions at high energies and small momentum transfers is of great interest for determination of the isotopic structure of the radiative decays of nucleon resonances. (auth)

6682 AN ANALYSIS OF ELECTRON DENSITY FLUCTUATIONS IN AIR SHOWER CORES AND THE QUESTION OF LARGE TRANSVERSE MOMENTA. Samorski, M.; Staubert, R.; Truemper, J.; Boehm, E.; Buescher, W.; Fritze, R. (Univ., Kiel). Z. Phys.; 230: 1-17(1970).

Electron density distributions in air shower cores recorded with the 32-m^2 neon hodoscope of the Kiel array were analyzed, looking for the existence of significant multicores which might result from large transverse-momentum emission of high-energy particles. The shower sizes are between 10^4 and 5×10^5 particles, corresponding to primary energies up to a few times 10^7 GeV. Several spurious effects simulating multicores were found, but there are no indications for the existence of large transverse momenta. (auth)

6683 PHOTOPRODUCTION OF MUON PAIRS: $\rho^0 \rightarrow \mu^+ + \mu^-$, (e,$\mu$) UNIVERSALITY, AND ($\rho,\omega$) PHASE. Rothwell, P. L.; Chase, R. C.; Earles, D. R.; Gettner, M.; Glass, G.; Lutz, G.; von Goeler, E.; Weinstein, Roy (Northeastern Univ., Boston). Phys. Rev. Lett.; 23: 1521-6(29 Dec 1969).

Data on photoproduction of muon pairs are reported and compared with quantum electrodynamics. A new average value of $B_\rho = (\rho^0 \rightarrow \mu^+ + \mu^-)/(\rho^0 \rightarrow \text{all}) = (8.2 \pm 1.6) \times 10^{-5}$ is obtained. Comparison with B_ρ for electron pairs provides a valid experimental confirmation, to "distances" of 1.6×10^{-14} cm, of (e,μ) universality for vertices involving timelike photons. The paradoxical agreement of values of B_ρ for photoproduction experiments with those for colliding beams are interpreted in terms of the ρ, ω phase. (auth)

Weak

6684 SEARCH FOR MUONIUM-ANTIMUONIUM COVERSION. Amato, James Joseph. New Haven; Yale Univ. (1968). 116p.

Thesis.

The possibility that the leptonic number conservation law is multiplicative in character rather than additive cannot be ruled out by present experimental evidence. Observation of the possible conversion of muonium ($M = \mu^+e^-$) to antimuonium ($\bar{M} = \mu^-e^+$) would establish the multiplicative nature of the law. It would also indicate the existence of neutral lepton currents in the weak interaction Hamiltonian. A search for the M-$\bar{M}$ conversion process was carried out at the Nevis synchrocyclotron. Muonium was formed by stopping positive muons in purified argon gas. Detection would take place by means of the inelastic scattering of $\bar{M}$ atoms in the gas, entailing capture of a μ^- by a gas atom. The signature of conversion would be the appearance of the 2P-1S argon muonic X-ray of 643 keV following a stopped μ^+. Detection efficiency and energy resolution are checked by observation of the same X-ray using the negative muon beam. The observed conversion rate was compatible with zero, and the results placed an upper limit on the possible magnitude of the M-$\bar{M}$ coupling constant, assuming a 4-fermion weak interaction of the universal V-A form. This limit was 6700 times the magnitude of the vector coupling constant of β decay, and represents a confidence level of better than 95%; this is the first quantitative information concerning the M-$\bar{M}$ coupling constant. Future extensions of this experiment to greater sensitivity are discussed. (Diss. Abstr.)

Strong (Baryon-Induced)

6685 (BNL-14126) A SURVEY OF EXPERIMENTAL RESULTS ON MULTI-PARTICLE PRODUCTION FROM HIGH ENERGY pp AND Kp COLLISIONS. Panvini, R. (Brookhaven National Lab., Upton, N. Y.). [1969]. 50p. (CONF-690928-1). Dep. CFSTI.

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y.

Experimental results are presented on multi-particle production from pp reactions for beam momenta ranging from 10 to 30 GeV/c from both counter and bubble chamber data. Some Kp bubble chamber results at ~10 GeV/c are presented for comparison. Several points of view of the data are taken and a few dominant features emerge. In the high energy limit, one- and two-pion production results from the formation at low |t| of a low mass cluster which contains one of the final state nucleons along with the one or two pions. From detailed studies of final states with three and more pions, there is also an indication that at least in some of these cases all the produced pions come from a single peripherally produced cluster containing a nucleon and all the pions; however, the cluster is not a distribution at low mass as when only one or two pions are produced. Furthermore, the tendency for the produced pions to group themselves around zero longitudinal momentum in the overall center of mass frame makes it difficult to reach a definite conclusion regarding how they are produced since this behavior can easily be explained from more than one point of view at present accelerator energies. The ratios between various cross sections from "off-shell" π^-p scattering derived from 28.5 GeV/c pp data were compared with the corresponding ratios between "on-shell" π^-p cross sections resulting in good overall agreement. The "off-shell" or virtual π^- is assumed to be produced at a vertex where an incident proton transforms into an outgoing Δ^{++} at low |t|. In addition, differential cross sections are presented for reactions $pp \rightarrow pM$ at 28.5 GeV/c, where $M < 2.1$ GeV, and $pp \rightarrow \pi^+ + (\text{anything})$ at 12.2 and 12.5 GeV/c. The exponential slope of the momentum transfer distributions to either p in the first reaction or the π^+ in the latter reaction is very steep at low momentum transfers and much shallower at large momentum transfers. The above subjects are discussed in detail along with other general information that is presented. (auth)

6686 DEUTERON-DEUTERON INTERACTIONS AT SIX LABORATORY MOMENTA FROM 680 TO 2120 MeV/c. Goshaw, A. T. (Princeton Univ., N. J.); Oddone, P. J.; Bazin, M. J.; Sun, C. R. Phys. Rev. Lett., 23: 990-4(Oct. 27, 1969).

The elastic and total cross sections for deuteron–deuteron interactions at 680, 920, 1180, 1500, 1750, and 2120 MeV/c are presented. The data are compared with theoretical calculations and shown to be in qualitative agreement with predictions based on the Glauber multiple-scattering formalism. In particular the existence of large-angle deuteron–deuteron elastic scattering provides evidence for the "simultaneous" scattering amplitudes predicted by the Glauber theory. (auth)

6687 MEASUREMENT OF PROTON–PROTON TRIPLE SCATTERING PARAMETERS AT 2 GeV. Carithers, William Cornelius Jr. New Haven; Yale Univ. (1968). 76p.
Thesis.

The Wolfenstein triple scattering parameters, R, D, A′ are measured for p-p scattering at 1.9 GeV. For scattering at 90° in the center of mass system, $R = 0.11 \pm 0.16$, $A' = -0.54 \pm 0.16$, and $D = 0.91 \pm 0.21$ are found in the cm system. The possibility of a vector character for the strong interactions is discussed. It is concluded that neither a single pseudoscalar meson nor a single vector meson exchange can account for the data. Spin effects are found to remain an important part of the nucleon–nucleon interaction at four momentum transfer $-t = 1.8$ (GeV/c)^2. (Diss. Abstr.)

6688 QUASI-FREE SCATTERING OF 1 GeV PROTONS FROM ^{12}C AND ^{40}Ca. Corley, Daniel Martin. College Park, Md.; Univ. of Maryland (1968). 150p.
Thesis.

^{12}C and ^{40}Ca targets were bombarded with 1-GeV protons and the energy spectra of secondary protons were measured. The angular range covered was 9 to 20° for ^{12}C and 9 to 17° for ^{40}Ca. Excitation energies of up to 320 MeV were measured. In each spectrum a broad peak was observed, the maximum of which was located near the energy expected for free nucleon–nucleon scattering. Quasi-free spectra were calculated, using a plane wave impulse approximation. Relativistic kinematics were used and the recoil of the final nucleus was taken into account. The quasi-free peaks were compared to experiment and it was found that the peaks had to be normalized and shifted in energy to obtain agreement with the data. The shapes of the predicted spectra agreed very well with experiment although at larger angles the theoretical spectra decreased below experiment on the high energy side of the peaks. The effects of absorption and multiple scattering were studied by calculating an expression for the total inelastic scattering in a high-energy multiple scattering approximation. It was found that, due to the large nucleon–nucleon absorption, only a small fraction of the nucleons in the nucleus could participate in the quasi-free process. Multiple scattering was found to be a small effect with only double scattering contributing significantly to the cross section. The normalization factors which were required in the plane wave impulse calculation were accounted for consistently (to within 20%) by including the effects of absorption and multiple scattering. The energy shifts were partially accounted for by the effect of preferential absorption in which the states with highest binding energies contribute less than those of low binding energies. The failure of the plane wave impulse approximation in the wings of the spectra at large angles, was examined from the point of view of correlations. A crude estimate of correlation effects in the ^{12}C spectra was made and found to be in rather good agreement with experiment. (Diss. Abstr.)

Strong (Meson-Induced)

6689 (COO-427-97) APPLICATION OF THE VENEZIANO MODEL IN THE REACTION $\pi^+ d \rightarrow d\pi^+\pi^-\pi^+$ AT 5.4 GeV/c. Derry, B. J.; Mansfield, J. E.; Biswas, N. N.; Cason, N. M.; Kenney, V. P.; Poirier, J. A.; Shephard, W. D. (Notre Dame Univ., Ind. Dept. of Physics). [1969]. Contract AT(11-1)-427. 16p. Dep. CFSTI.

The Veneziano model was applied for the spin–parity 1^+ case to the low-mass 3π system produced in the reaction $\pi^+ d \rightarrow d\pi^+\pi^-\pi^+$, and the results were compared with those for a symmetrized α-pole model. It was found that a nonzero $\epsilon^0\pi$ decay mode is needed to fit the Dalitz plot of the 3π system. The Veneziano model inherently incorporates the daughter ϵ^0 contribution along with the parent ρ trajectory in the amplitude and gives a good fit to the data with a value of $G_s/G_d = -0.15^{+1.1}_{-0.9}$ GeV^2, where G_s and G_d are related to the s- and d-wave $A_1\,\rho\pi$ couplings. A symmetrized pole model can only be made to fit the data if both ρ and ϵ^0 pole contributions are assumed. (auth)

6690 (LAL-1222) EXPERIMENTS WITH THE ORSAY STORAGE RING ACO. Perez-y-Jorba, J. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Sep 1969. 37p. (CONF-690911-2). Dep. CFSTI (U. S. Sales Only).

From International Symposium on Electron and Photon Interactions at High Energies, Daresbury, England.

Various experiments using the Orsay storage ring are described. These experiments are the meson (ϕ) decay into K^+ and K^-, meson (ϕ) decay into K_1^0 and K_2^0 and meson (ϕ) decay into 3π, 2π production and $\omega-\rho$ interference. Also quantum electrodynamics experiments are discussed including double bremsstrahlung luminosity measurement, QED test in Bhabha scattering, and the $\mu^+\mu^-$ test of QED. Beam polarization, coupling constants and sum rules, and finite width effects and vacuum polarization are also discussed. (J.F.P.)

6691 (UH-511-60-69) HIGH ENERGY PHYSICS GROUP ANNUAL PROGRESS REPORT. (Hawaii Univ., Honolulu. Dept. of Physics and Astronomy). 15 Oct 1969. Contract AT(04-3)-511. 79p. Dep. CFSTI.

The report of the high-energy physics group at the University of Hawaii covers research for the year 1969. This research is both experimental and theoretical and includes bubble and spark chamber experiments. Publications and reports issued during this period are also listed. (J.F.P.)

6692 POSITIVE K MESON–NUCLEON CHARGE EXCHANGE SCATTERING NEAR 600 MeV/c. Ray, Asim Kumar. Pittsburgh; Carnegie-Mellon Univ. (1969). 151p.
Thesis.

The K° angular distribution and the proton polarization produced in $K^+n \rightarrow K^0p$ scattering near 600 MeV/c were measured and analyzed in terms of partial waves. The data were extracted from events obtained in several exposures of the BNL 30 in. deuterium bubble chamber to a beam of separated positive K-mesons. A phase shift analysis incorporating the angular distribution and polarization data was carried out assuming either pure S wave or a mixture of S and P waves in the I = 1 channel. These analyses have established that the K-N interaction in the I = 0 channel is described by the Yang type solutions in which $\delta_{p_{\frac{1}{2}}}^{I=0}$ increases with increasing K-N cm energy. The inclusion of I = 0 D waves, which is necessary with pure S wave in the I = 1 channel, is optional if both S and P waves are included in the I = 1 channel. This implies that a simple but consistent description of the K-N interaction near 600 MeV/c requires S and P wave scattering in both the I = 0 and I = 1 channels. The variation of the phase shifts with K-N cm energy and the influence of form factor and closure approximations on the phase shifts were also investigated. (Diss. Abstr.)

6693 A STUDY OF K^- MESON CAPTURES IN DIAMOND-LOADED EMULSIONS. Chinn, Leung. Seattle; Univ. of Washington (1968). 85p.
Thesis.

Nuclear emulsions loaded with small diamond crystals were exposed to stopping K^- mesons at the Berkeley Bevatron. A total of 43 interactions in diamond were found by area scanning. They were analyzed and the results were compared to data obtained for K^- captures on light nuclei in photographic emulsions. It was found by examination of the diamond events that the conventional methods used for separating events into the "light" and "heavy" nuclei of the emulsion are not very reliable. In addition the carbon data contained no events with a charged $\Sigma\pi$ pair. A preponderance of Σ^- hyperons compared to Σ^+ hyperons was also observed. The idea of a neutron excess on the surface of a carbon nucleus is suggested as a possible resolution of these difficulties. (Diss. Abstr.)

6694 SEARCH FOR A BOUND Σ^- NEUTRON STATE. Gustafson, Herold Richard. Seattle, Wash.; Univ. of Washington (1968). 284p.
Thesis.

The mass spectrum of the Σ^- neutron system was measured in the reaction $\pi^- + d \rightarrow \Sigma^- + n + K^+$. A missing-mass spectrometer was used. This consisted of: a bending magnet-spark chamber pion momentum analysis system; a K Telescope using scintillation and Cherenkov counters with an electronic logic system; and a spark chamber range angle measuring system to determine the K energy and the π-K production angle. The data yielded an upper limit on the differential cross section for the production of a (Σ^-,n) bound state in $\pi^- + d \rightarrow (\Sigma^-n) + K^+$ at the 90% confidence level of 1.1×10^{-31} cm^2/str for $M_{(\Sigma^-n)} < 2137$ MeV/c^2, $P_\pi = 1.150$ MeV/c, $180 \leq T_K \leq 320$ MeV, and $30° \leq \theta_K \leq 60°$. (Diss. Abstr.)

6695 PRODUCTION OF $p\pi^+\pi^-$ ENHANCEMENTS FROM THE REACTION $K^-p \rightarrow K^-p\pi^+\pi^-$ AT 3.9, 4.6, AND 7.3 GeV/c. Barnes, V. E.; Bassano, D.; Chung, S. U.; Eisner, R. L.; Flaminio, E.; Kinson, J. B.; Samios, N. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 1516-20(29 Dec 1969).

Evidence is presented for the existence of an N*(1710) (M = 1712 ± 6 MeV and Γ = 70 ± 15 MeV) produced in the reaction $K^-p \rightarrow K^-p\pi^+\pi^-$ at incident momenta of 3.9, 4.6, and 7.3 GeV/c. It decays mainly into $p\pi^+\pi^-$ and not through the $\Delta^{3+}\pi^-$ intermediate state, with some indication for a ΛK^+ decay mode. Also observed in the $p\pi^+\pi^-$ invariant mass spectrum is the N*(1470). (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 6297, 6691, 6763, and 6765.

6696 FORM FACTORS IN CLASSICAL DYNAMICS. Blochinzev, D. (Joint Inst. for Nuclear Research, Dubna, USSR). Z. Phys.; 229: 199-205(1969). (In German).

The classical dynamics of extended particles is considered. The restrictions imposed on the form factors by the Lorentz and gauge invariance as well as by causality are shown. (auth)

6697 ABOUT THE QUESTION OF PHYSICAL APPLICATION OF NONASSOCIATIVE ALGEBRAS. Jordan, P. Z. Phys.; 229: 193-8(1969). (In German).

It was previously proposed to try whether the mathematical theory of non-associative algebras may be a suitable tool for a generalization of existing quantum theory (towards a new theory ascribing to the elementary length l a similarly fundamental meaning as to the constant h). The mathematical laws of the so-called Lie triple algebras were studied in order to get information about the simplest mathematical generalizations of power associative algebras. The chief results of this mathematical study are briefly reported. (auth)

6698 ON WAVE EQUATIONS IN DE SITTER SPACE. Vidal, A. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 15: No. 6, 83-8 (1969).

Equations are formulated in tensor and spin-tensor forms for the cases of free particles of spins 1, 2, and $^3/_2$ respectively. These equations are generalizations of the Dirac equation for spin-$^1/_2$ particles in de Sitter space. (J.F.P.)

6699 FACTORIZATION PROPERTIES OF THE DUAL RESONANCE MODEL: A GENERAL TREATMENT OF LINEAR DEPENDENCES. Chiu, Charles B.; Matsuda, Satoshi; Rebbi, Claudio (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev. Lett.; 23: 1526-30(29 Dec 1969).

In the dual resonance model, introducing a generalized gauge-transformation operator which leaves the vertex functions invariant, a general treatment of linear dependences among the vertex functions is presented. It is proved that the two propagators recently discussed in connection with the twisting operator are equal up to our gauge transformation. (auth)

Electromagnetic

Refer also to abstracts 6681, 6752, and 6756.

6700 (CALT-68-219) SINGLE PION PHOTOPRODUCTION IN THE RESONANCE REGION. Walker Robert L. (California Inst. of Tech., Pasadena). Sep 1969. Contract AT(11-1)-68. 47p. (CONF-690911-3). Dep. CFSTI.

From International Symposium on Electron and Photon Interactions at High Energies, Daresbury, England.

A brief review of pion photoproduction in the resonance region, a discussion of a simple quark model of baryons, previously given, for the main features of the interaction studied, and a survey of related recent experimental data are presented. (J.F.P.)

6701 WAVE EQUATION OF CHARGED PARTICLE OF SPIN 1: THE KEMMER EQUATION. Gupta, S. (Univ. of Calcutta). Indian J. Phys.; 43: 92-103(Feb 1969).

The Kemmer relativistic wave equation of a particle of spin one or zero and particularly the commutation relations of Duffin-Kemmer β-matrices were obtained by the generalization of the corresponding nonrelativistic wave equation. This covariant formulation is achieved by making a Lorentz transformation to a reference frame in which the velocity is small and also by generalizing the concept of spin and spin space. (auth)

6702 SCATTERING OF SPIN ONE-HALF PARTICLES FROM ONE-DIMENSIONAL ELECTROSTATIC POTENTIALS. Feder, R.; Meister, H. J. (Univ., Munich). Z. Phys.; 229: 309-15(1969).

By means of a covariant formalism for the description of spin the scattering of polarized spin one-half particles from electrostatic potentials that depend on only one space coordinate is investigated. For an arbitrary potential the scattering intensity is found to be independent of the polarization of the initial beam. The polarization vector is rotated about an axis normal to the plane of incidence through an angle that only depends on the energy and the angle of incidence of the initial beam. (auth)

6703 MESON-SCATTERING DYNAMICS. Crater, Horace William. New Haven; Yale Univ. (1968). 298p.

Thesis.

Related problems are discussed which involve the techniques of current algebra and the physical hypothesis of partially conserved axial-vector currents (PCAC). The N point Lorentz covariant current correlation function is utilized to set up the asymptotic chiral U(3) ⊗ U(3) symmetry with which the electromagnetic self mass matrix is calculated. With the Okubo form of the second Weinberg sum rule special pains are taken to elicit the correct sign for the kaon electromagnetic mass difference. In an effort to comprehend the significance of model dependent sigma terms in an otherwise model independent treatment of current algebra a broken chiral U(3) ⊗ U(3) invariant sigma model is investigated in detail. The model is then applied to the computation of pseudoscalar meson scattering lengths and decay rates of the sigma mesons. Employing the current algebra expansion techniques developed the study of nonleptonic meson-meson interactions is considered. The method is different from that originally worked out by Weinberg. All of the mesons are reduced out, and distinction is not made among them with respect to the PCAC divergence condition. By following this method a systematic way is found besides that of ignoring them, to handle sigma terms. The sigma masses predicted by the sigma model go into this exposition. Meson-meson scattering amplitudes and scattering lengths are calculated, and the results are compared with those from the independent sigma model and those predicted by the effective nonlinear Lagrangian models. These techniques are brought to bear upon the $K \rightarrow 3\pi$ and $K \rightarrow 2\pi$ decay amplitudes. (Diss. Abstr.)

6704 CALCULATION OF THE ENERGY DEPOSITED IN THICK TARGETS BY HIGH-ENERGY (1-GeV) ELECTRON-PHOTON CASCADES AND COMPARISON WITH EXPERIMENT. Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 38: 131-4(Nov. 1969).

Electron-photon cascade calculations were carried out for zero-width beams of 1-GeV electrons normally incident on semi-infinite slabs of water and aluminum. The energy deposited as a function of depth and radius is presented and compared with experimental measurements. The overall agreement between the calculated and experimental results is quite good and is adequate for most shielding purposes. (auth)

6705 VECTOR MESON DOMINANCE AND PHOTOPRODUCTION. Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg). Z. Phys.; 229: 278-98(1969).

A brief review of the basic principles of the vector meson dominance model is given. The model is then compared with most recently obtained experimental results. It is stressed that it provides a simple and unified interpretation of photoproduction of hadrons at high energies. (auth)

6706 COULOMB FORCE IN THE THREE-BODY PROBLEM. Hamza, Khidhir Abdul-Abbas. Tallahassee, Fla.; Florida State Univ. (1968). 114p.

Thesis.

A formal modification, by including the Coulomb potential, of the scattering equations describing three particles interacting via short-range separable potentials given by Lovelace is discussed in terms of the exact Coulomb Green's function. An approximation scheme for the case of two charged particles and one neutral in the framework of the Schulman approximation is presented. A systematic solution using deformed contours is explained in detail. Numerical results for deuteron induced reactions on ^{16}O are compared with experimental data, and quite acceptable fits are obtained. (Diss. Abstr.)

6707 VECTOR-DOMINANCE MODEL AND DEEP INELASTIC ELECTRON-PROTON SCATTERING. Tung, Wu-ki (Stanford Linear Accelerator Center, Calif. Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett.; 23: 1531-4(29 Dec 1969).

The vector-dominance model for inelastic e-p scattering is reexamined using an invariant procedure which also satisfies gauge invariance and all kinematic analyticity requirements. By explicitly exhibiting the inherent arbitrariness in the choice of extrapolation functions, it is shown that the previous prediction of large σ_S/σ_T at large q^2 (which disagrees with recent data) is not a general feature of this model. Alternative examples which also satisfy both of Bjorken's scaling conditions are given. (auth)

Weak

6708 WEAK INTERACTIONS. Nagy, Tibor (Lorant Eoetvoes Univ., Budapest). Magy. Fiz. Foly.; 17: 345-80(1969). (In Hungarian).

The results obtained during the last few years in the field of

weak decay of elementary particles are reviewed, considering especially the interactions of pseudoscalar mesons and $\frac{1}{2}^+$ baryons. The weak interaction is treated on the basis of the perturbation theory; the strong and electromagnetic interactions are neglected. The processes considered include leptonic, semileptonic and nonleptonic decays of hadrons. The first observed case of the nonconservation of the CP invariance, the decay of K mesons into 2 pions is discussed in detail, describing the phenomenology and the more recent experimental data of the $K \to \pi\pi$ decay, to decide whether the process involves also a nonconservation of the T and CPT invariances. (Review article, 49 refs.) (TTT)

6709 CHIRAL DYNAMICS AND K_{μ} FORM FACTORS. Murtaza, Ghulam; Harun-ar-Rashid, A. M. (Univ. of Islamabad, Rawalpindi, Pakistan). Z. Phys.; 230: 65-71(1970).

The axial vector form factors for the decay K_{μ} are studied in the context of effective Lagrangian invariant under chiral SU(3) ⊗ SU(3) symmetry. The hadronic part of the process is converted into a scattering process by using a field-current identity and the amplitude in turn is calculated by assuming pole dominance. The relations for the form factors thus obtained are (in some soft limit) consistent with those of current algebra and Veneziano model. (auth)

Strong (General)

Refer also to abstract 6766.

6710 A STUDY OF RELATIVISTIC MANY-PARTICLE SYSTEMS. Chervenak, William James. Clemson, S. C.; Clemson Univ. (1968). 85p.

Thesis.

Using the self-consistent field technique, the collective oscillations in a relativistic N-body system are described. To treat the N-electron system, existing in a neutralizing background of positive charge, the Dirac equation is used to obtain an equation of motion for the single particle density operator. Since the electromagnetic fields which constitute the interaction arise from density fluctuations, the Maxwell equations governing these fields contain the density matrix. The density operator equation is linearized and an expression for the matrix elements of the density fluctuation is found. Then, substituting for the density matrix in Maxwell's equations and using the Lorentz gauge condition, the self-consistent equations are separated. The dispersion equations and thus the energy spectrum for longitudinal and transverse modes result immediately. That this formula is valid for the relativistic case is shown by demonstrating that the dispersion equations reduce to the proper form in the nonrelativistic and classical limits. This method is shown to be equivalent to a second quantized approach in that an appropriate average of the second quantized density operator equation yields the corresponding quantum mechanical equation. A consideration of the relation between corresponding operators in the two formulations shows that agreement is obtained only for physical properties depending on single particle operators. A longitudinal dispersion equation for a system of hadrons interacting through a neutral pseudoscalar meson field is derived using this technique. The first system studied is prepared such that initially positive energy particles are present in a background of filled negative energy states. Subsequently, the system is taken to consist of an equal number of particles and anti-particle interaction energy is obtained by considering the dispersion equation for zero momentum transfer. This interaction energy is related to the meson mass and a procedure for estimating this mass is outlined. Certain integrals of the various dispersion equations in the zero temperature and long wavelength limit are displayed. (Diss. Abstr.)

6711 PERMUTATION OF THREE QUARK TRIPLETS. Krolikowski, W. (Inst. of Nuclear Research, Warsaw. Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 17: 513-15(1969).

It is pointed out that the original field interaction for attractive and repulsive forces between the three smallest eigenvalues corresponding to three quark triplets of a complex quark charge is in a sense invariant under cyclic permutations of three triplets. It is noted that the argument is independent of the construction of configurational Hamiltonians and is valid only for cyclic permutations. (J.F.P.)

6712 OCTET ENHANCEMENT IN HADRONIC INTERACTIONS. Chan, Choi-lai Stephen. Vancouver, B. C.; Univ. of British Columbia (1968).

Thesis.

A detailed study is made of the phenomenon of octet enhancement in hadronic interactions. After a survey of the experimental consequences of octet enhancement is made, a review and discussion of the various theories of octet enhancement is given. A general group theoretical discussion, based on an extension of Glashow's method (S. L. Glashow, 1963), of spontaneous symmetry breaking is presented. A general theorem in connection with spontaneous symmetry breaking is stated and proved. The theorem lends itself to a number of interesting applications. Among these is a demonstration that if a unitary triplet exists in nature which is nontrivially coupled to the rest of the hadrons, then octet enhancement follows without recourse to any detailed dynamical assumption. In particular, the triplet need not be quarks in the sense of fundamental building blocks of all matter. It is also demonstrated group theoretically that $\phi-\omega$ mixing can in principle occur as a particular form of spontaneous symmetry breaking, in exactly the same way that a spontaneous mass splitting can occur. Assuming octet dominance in the symmetry breaking of a degenerate nonet of vector mesons, it follows quite generally that the formulas (i) $m_{\omega}^2 + m_{\phi}^2 = 2m_{K^*}^2$ and (ii) $m_{\rho}^2 + 3(\cos^2\theta\, m_{\phi}^2 + \sin^2\theta\, m_{\omega}^2) - 4m_{K^*}^2 = 0$ must hold. Here again, no dynamical detail is required. A bootstrap model consisting of an octet of vector mesons is constructed with which it is demonstrated step by step how octet enhancement follows from the intricate working of two dynamical principles — (a) the bootstrap hypothesis and (b) that the mesons participating in the bootstrap must be physical particles and not ghost states. The model is extended to study $\phi-\omega$ mixing. A phenomenon which can be interpreted as a "spontaneous" $\phi-\omega$ mixing is found to in fact occur. Furthermore, formulas (i) and (ii) also emerge from this model. The only extra assumption besides (a) and (b) made the mere "existence" of a unitary singlet vector meson whose "bare" mass (the mass of the particle before it is embroiled in the bootstrap) is equal to average mass of the octet. (Diss. Abstr.)

6713 HADRON SPECTRUM. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel). Fiz. Szemle, 19: 270-9(1969). (In Hungarian).

The resonant hadron states are very short-lived and do not leave tracks in emulsions or in bubble chambers. Their existence and properties are determined by scattering experiments with long-lived hadrons. The properties of the hadron spectrum may be derived from experimental observations. At low energies, up to 1 to 2 GeV, the collision reactions of hadrons are dominated by the presence of resonances, supplemented by a nonresonant background. Analysis of the resonance spectrum indicates that the resonances may be arranged in multiplets defined by the quantum numbers of the quark model, the SU(3) and SU(6) schemes. At intermediate and high energies the cross section measurements point to the possible existence of exchange mechanisms with characteristic forward and backward scattering peaks. Beyond 6 GeV, Regge trajectories prevail. The cross sections do not increase with energy and the scattering processes may be divided into two separate groups according to the properties of the cross sections and resonances. Predictions of the quark model agree with the observed hadron spectra. (TTT)

6714 EFFECT OF np REPULSIVE CORE IN Ad SCATTERING. Schick, L. H. (Univ. of Southern Calif., Los Angeles). Phys. Rev., 182: 1106-12(June 20, 1969).

The Ad spin-$\frac{1}{2}$ elastic and total cross sections are calculated for incident Λ laboratory momentum $p_{\Lambda} \leq 400$ MeV/c using a Faddeev three-body formalism. Only $^3S_1$ ΛN and $^3S_1$ np interactions are used. The former is represented by a sum of two separable potentials, one attractive, the other a repulsive core. The np interaction is represented by two such potentials adjusted to both the low-energy data and the phase shift at 150 MeV in the c.m. system, or by a single separable potential adjusted to only the low-energy data. The presence of the np core potential changes the S-wave Ad cross sections by at most 15% (this at $p_{\Lambda} = 400$ MeV/c), while with all significant partial waves included the maximum change in the Ad cross sections is less than 2%. (auth)

6715 PROTON–PROTON P-WAVE PHASE SHIFTS AT LOW ENERGIES. Heller, Leon (Los Alamos Scientific Lab., N. Mex.); Sher, Michael S. Phys. Rev., 182: 1031-4(June 20, 1969).

The question of whether linear combinations Δ_C, Δ_T, and Δ_{LS} of the three proton–proton triplet P-wave phase shifts contain direct information about the central, tensor, and spin-orbit potentials, as would be the case if the Born approximation were valid, is studied using two potential models. It is found that significant correlations exist between the potentials and the Δ's for the tensor and spin-orbit pieces, but that Δ_C bears no direct relation to V_C. The reliability of Noyes's restriction on Δ_{LS}/Δ_T is discussed. (auth)

Strong (Baryon No. = 0)

6716 (COO-264-524) VECTOR-MESON DOMINANCE: PRESENT STATUS AND FUTURE PROSPECTS. Sakurai, J. J.

(Chicago Univ., Ill. Enrico Fermi Inst. Chicago Univ., Ill. Dept. of Physics). Oct 1969. Contract AT(11-1)-264. 36p. (EFI-69-91). Dep. CFSTI.

The review of vector meson dominance covers the current-field identity, comparison of $\rho^0 \to e^+ + e^-$ and $\rho^0 \to \pi^+ + \pi^-$, the ρ-photon analogy, single-pion photoproduction and frame dependence, vector meson photoproduction and total photoabsorption cross sections, a table for the meson (ρ) coupling constant, broken SU(3) and ω-ϕ mixing, and the classical versus the frontier region, also other vector mesons, asymptotic behavior of the colliding beam cross section, the nucleon form factor, inelastic electron-proton scattering, and future experiments are discussed. (J.F.P.)

6717 GENERALIZED VENEZIANO MODEL FROM THE POINT OF VIEW OF MANIFESTLY CROSSING-INVARIANT PARAMETRIZATION. Koba, Ziro; Nielsen, Holger Bech (Univ. of Copenhagen). Z. Phys.; 229: 243-63(1969).

The construction of the Veneziano-type n-point function with manifestly crossing-invariant parametrization is reviewed in a heuristic way. Here, one meets a divergence problem, the solution of which is discussed in detail. Equivalence to previous works and its asymptotic behavior are rederived with the help of affine group representation. (auth)

6718 SOME ALGEBRAIC MASS CALCULATIONS. Wiegand, J. G. (Univ., Munich). Z. Phys.; 229: 410-19(1969). (In German).

By self-consistency requirements the masses of the ϵ-, ρ-, and f^0 mesons are calculated using new techniques for unitarizing exchange diagrams. The results are in fairly good agreement with experiment; the new method is based on the topological properties of the Riemann energy surface of partial wave amplitudes. (auth)

Strong (Baryon No. = 1)

6719 (UCRL-20000) COMPILATION OF K^+N REACTIONS. Price, LeRoy R.; Barash-Schmidt, Naomi; Benary, Odette; Bland, Roger W.; Rosenfeld, Arthur H.; Wohl, Charles G. (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1969. 234p. Dep. CFSTI.

There are 90 papers reporting K^+N and K^+d interactions compiled. Cross sections, angular distributions, and polarizations are displayed. Included are indices to the papers, as well as a complete listing of the selected K^+N data and results of the fits to some of the data. The cutoff date for this report was 15 July 1969. (auth)

6720 WHAT ARE THE RANGE AND TIMES OF HIGH-ENERGY INTERACTION OF PARTICLES? Lendel, A. I.; Lomsadze, Yu. M.; Tokar, S. S.; Chizhikov, V. V. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh., 14: 1519-24(Sept. 1969). (In Russian).

It is shown that in the expression for the amplitude of emission of an arbitrary number of soft photons through the main reaction amplitude the first derivatives of this amplitude with respect to mass of scattering particles are absent for any relation between the energies of photons. A new method is proposed for obtaining experimental information on the effective space-time regions $\sigma^{\perp}(s)$ and $\sigma^0(s)$ of the particle interaction at high energies. The method is based on experimental study of the ratio $\alpha\sigma_\gamma/\alpha\sigma$ of the differential cross sections of the bremsstrahlung reaction of soft photon to the differential cross section of the main reaction at large s in a certain region of t change. (auth)

6721 PARTIAL WAVES AND EXCHANGE MODELS IN REACTIONS $\pi N \to \pi\pi N$. II. Bijtebier, J. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg.; 55: 423-51(1969). (In French).

A theoretical framework to be used in the analysis of the experimental data for the reaction $\pi N \to \pi\pi N$ in terms of partial wave amplitudes and amplitudes corresponding to peripheral production of N^* and ρ is presented. Previously the amplitudes describing $\pi N \to \pi\pi N$ in terms of Pauli spinors and matrices were expressed. Results are derived in terms of spherical harmonics and Clebsch-Gordan coefficients. The final amplitude contains various admixtures of partial wave and exchange amplitudes. The probability distributions and also the recoupling coefficients corresponding to different final state interactions are calculated. The partial-wave expansion of exchange amplitudes is developed and finally the case in which the initial nucleon is polarized is examined. (auth)

6722 THE ANGULAR DECAY DISTRIBUTIONS OF $N^*(1236)$ IN THE PHOTOPRODUCTION PROCESS $\gamma p \to \pi^- N^{*++}(1236)$ IN THE QUARK MODEL. Gorczyca, B.; Hayashi, M. (Jagellonian Univ., Krakow). Acta Phys. Pol.; 36: 783-6(Nov. 1969).

The constraints on the decay angular distributions of $N^*(1236)$ produced in the process $\gamma p \to \pi^- N^{*++}(1236)$ were discussed according to Białas-Zalewski classification. It is shown that relations obtained for the process induced by unpolarized photons seem to be satisfied in the Donohue-Högaasen frame of reference. The predictions on the decay angular distributions of $N^*(1236)$, cross sections and asymmetry parameter are given for the process induced by polarized photons. (auth)

6723 SOME REMARKS ON HARARI'S MODEL AND THE DIRECT-CHANNEL RESONANCE MODEL FOR PION-NUCLEON SCATTERING. Shastry, C. S. (Louisiana State Univ., Baton Rouge). Nuovo Cim., Lett.; 2: 614-18(1 Nov 1969).

The validity of the Harari model at forward angles for $\pi^- + N$ interactions below 1.6 GeV is examined. The reasons why the direct-channel resonance model can be expected to work at backward angles are discussed. (J.F.P.)

6724 CHIRAL SYMMETRY BREAKING: MESON AND NUCLEON MASSES. Griffith, Richard William. Pasadena, Calif.; California Inst. of Technology (1969). 80p.
Thesis.

From consideration of the role in current algebra of the equal-time commutator involving an axial vector charge and divergence of the axial vector current, estimates of meson and nucleon scalar density matrix elements are given. The scalar densities, behaving as $(3,3^*) + (3^*,3)$ under the $SU(3) \times SU(3)$ algebra of vector and axial vector charges, participate in the $SU(3) \times SU(3)$ noninvariant part of an (abstracted) energy density. The meson scalar density matrix elements are estimated in connection with a $K\pi$, KK scattering length determination and a relation for the relevant symmetry breaking parameter $\varkappa$ which multiplies the octet algebraic scalar piece of the hadronic energy density. An application is given in which a $K\pi$ amplitude expansion, containing the information of a kaon scalar density term, is used in determining the low energy limits of a K_{l_4} form factor. The estimates for the nucleon scalar density terms are somewhat inconclusive and emphasis is placed on discussion of various dispersive approaches involved. (Diss. Abstr.)

6725 STRANGE-PARTICLE PRODUCTION IN PROTON-PROTON INTERACTIONS AT 5.4 AND 6.6 GeV/c. Dunwoodie, William McMeekin. Los Angeles; Univ. of California (1969). 361p.
Thesis.

The production of strange particles in proton-proton collisions is studied at beam momenta of 5.4 and 6.6 GeV/c. The interactions were photographed during an exposure of the Lawrence Radiation Laboratory 72-inch liquid hydrogen bubble chamber to secondary proton beams from the Bevatron. The total proton track lengths are equivalent to (6.1 ± 0.2) and (14.7 ± 0.4) events/μb at 5.4 and 6.6 GeV/c, respectively. Six production topologies are investigated: vee two-prong, two-vee two-prong, two-prong with a positive kink, two-prong with a positive kink and a vee, four-prong with a positive kink and four-prong with a negative kink. The kink is required to correspond to the decay of a charged sigma hyperon, and only those final states containing three or four particles are analyzed. Cross section determinations are made for such states, and it is found that no channel has a cross section greater than 100 μb. (TSS)(Diss. Abstr.)

6726 A NEW DETERMINATION OF THE πN COUPLING CONSTANT f^2. Hoehler, G.; Schlaile, H.; Strauss, R. (Univ., Karlsruhe, Ger.). Z. Phys.; 229: 217-23(1969).

The coupling constant f^2 was determined from forward dispersion relations for the πN helicity flip and nonflip amplitudes, using the recent information on total cross sections, phase shifts and charge exchange forward cross sections. The calculation gives also the values of the amplitudes and the first derivative at the crossing symmetry point. (auth)

6727 NEW EVIDENCE FOR NONFACTORIZATION OF PION EXCHANGE FROM SIGMA PRODUCTION. Garcia, A. (International Centre for Theoretical Physics, Trieste, Italy); Garcia Canal, C. A.; Odorico, R. Nuovo Cim., Lett.; 2: 619-23(1 Nov 1969).

Some high-energy data and some results of a phenomenological use of duality give clear evidence for the absence of a dynamical zero in the pion exchange contribution to the interaction $\pi^- + p \to \sigma + n$. This shows the inadequacy of a simple Regge-pole model to describe pion exchange. (J.F.P.)

6728 SIMPLE PHENOMENOLOGICAL REGULARITY OF NEAR-FORWARD ZEROS. Odorico, R. (Univ. Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cim., Lett.; 2: 624-7(1 Nov 1969).

The simple phenomenological regularity of the presence of near-forward zeros in the amplitudes of $\pi + N \to \pi + N$, $\pi + N \to \eta(\sigma) + N$, and $\gamma + N \to \pi + N$ interactions is discussed.

This observed regularity is that the dynamical near-forward zeros ($|t| \leq (0.2 \text{ to } 0.3)(\text{GeV})^2$) are found always to be simple and to be present in all regularized t-channel helicity amplitudes which contribute in the forward direction and only in these amplitudes. (J.F.P.)

Strong (Baryon No. ≥ 2)

6729 (AD-691488) PROGRAM TO CALCULATE PARTICLE SPECTRA PRODUCED IN HIGH-ENERGY PROTON-PROTON COLLISIONS BY THE TWO-TEMPERATURE STATISTICAL MODEL. Revised Edition. Wayland, James R.; LaPointe, Martin (Maryland Univ., College Park. Dept. of Physics and Astronomy). Apr 1969. Contract F44620-69-C-0019. 19p. (TR-844(Rev.); AFOSR-69-1927-TR). CFSTI.

In the past few years, the lack of success of older statistical models led to new models that rely more on phenomenological observations. One of the most successful models is the two-temperature model of Wayland and Bowen. The analytic form of this model allows easy extension of the predictions to cosmic ray energies. A brief outline of the two-temperature model is presented. The application of the model is considered. (Diss. Abstr.)

6730 OBSERVATIONS ON Λ OVERBINDING IN NUCLEAR MATTER. Clark, J. W.; Mueller, G. (Washington Univ., St. Louis). Nuovo Cim.; 64B: 217-39(11 Dec 1969).

New and old results of Jastrow calculations of the Λ binding energy in nuclear matter based on the effective central two-body N-Λ potentials of Herndon and Tang are collected and discussed. Arguments in favor of the reliability of the Jastrow evaluation are presented. The possibility of erasing the large discrepancy between the calculated results and the accepted empirical value for B_Λ by the incorporation of a three-body N-N-Λ potential, or by use of a two-body N-Λ potential with tensor component, is considered, and some tentative numerical work along these lines described. (auth)

6731 EFFECTIVE NONSINGULAR NUCLEON-NUCLEON INTERACTION. Hammann, T. F. (Univ., Strasbourg); Ho-Kim, Q. Nuovo Cim.; 64B: 356-66(11 Dec 1969).

An effective nucleon-nucleon potential which reproduces accurately experimental scattering phase shifts up to 400 MeV is presented. It is nonlocal and separable into smooth radial form factors of simple physical interpretation. The interaction acts on S, P, and D states and includes effectively central forces as well as other spin-dependent forces. (auth)

6732 INELASTIC INTERACTIONS OF HIGH-ENERGY PROTONS WITH ATOMIC NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; 36: 887-99(Nov 1969).

The Monte-Carlo method is used to calculate the intranuclear cascades initiated by protons of an energy from a few dozens of MeV to about 30 GeV. The law of energy-momentum conservation and the meson production processes are exactly taken into account. The evaporation from excited residue-nuclei is calculated. In the whole energy range from a few dozens of MeV to about 5 GeV the results of calculations are in good agreement with experiment; at higher energies there appear noticeable discrepancies in the characteristics of the low-energy component of produced particles. These discrepancies grow with increasing energy of the primary nucleon. An analogous disagreement between the experimental results and those obtained by the usual cascade theory takes place in the case of pion-nuclear interactions. (auth)

6733 SOME ASPECTS OF A BREMSSTRAHLUNG MODEL FOR HIGH-ENERGY ELASTIC NUCLEON-NUCLEON SCATTERING. Gemmel, H.; Kastrup, H. A. (Univ., Munich). Z. Phys.; 229: 321-8(1969).

Some aspects of a classical meson source which was used for the description of elastic nucleon-nucleon collisions is discussed. A detailed analytical discussion for very small and very large momentum transfers reveals some interesting simple features for the dominant factor of the elastic cross section. (auth)

Particle Invariance Principles and Symmetries

General

6734 (COO-1573-64) INTERNAL SYMMETRY CANNOT BE CONCEALED. Kantor, Paul B. (Case-Western Reserve Univ., Cleveland, Ohio). [1964]. Contract AT(11-1)-1573. 10p. Dep. CFSTI.

The problem of determining whether a given "particle" is elementary or is any member of a degenerate multiplet corresponding to an exact symmetry is considered. A double scattering experiment is discussed which can make this determination unless the members of the multiplet are unable to distinguish one another. Finally, such an inability is shown to be incompatible with the usual relation between spin and statistics and known analyticity properties of scattering amplitudes. (auth)

6735 CASIMIR OPERATORS ASSOCIATED WITH ANY LIE ALGEBRA. Mutze, U. (Univ., Munich). Z. Phys.; 229: 224-9(1969).

A characterization of the Casimir operators of a Lie algebra by polynomial solutions of a system of first-order partial differential equations is given. Further an upper bound is stated for the number of independent Casimir operators of a nilpotent Lie algebra. (auth)

6736 THE DECOMPOSITION OF THE PRODUCT OF A MOMENTUM-ZERO- AND A MASS-ZERO-REPRESENTATION OF THE POINCARE GROUP. Schaaf, Manfred (Univ., Munich). Z. Phys.; 229: 336-46(1969).

The irreducible unitary representations of a twofold covering group E(2) of the euclidean group of the plane are set up. The product of two irreducible unitary representations of E(2) and the irreducible unitary representations of SL(2,C) restricted to a subgroup E'(2) isomorphic to E(2) are reduced to irreducible unitary components. The results are applied to the decomposition of the product of a momentum-zero- and a mass-zero-representation of the proper orthochronous quantum-mechanical Poincaré group. (auth)

6737 FERMION THEORY IN NEW PARTICLE-ANTIPARTICLE CONCEPTION. Vahedi, N. (Technical Univ. of Aria-Mehr, Teheran). Z. Phys.; 229: 372-83(1969). (In German).

Bopp's method of quantization of relativistic field theories is applied to a theory possessing SU(3)-symmetry. This allows an investigation of the relation between group theory and dynamics. The Schrödinger operator used leads to exactly solvable equations in the case of two particles and permits investigation of binding and scattering. Meson masses are used for the determination of the parameters involved. Plausible values for the scattering cross sections are then obtained. Useful values are obtained for the cross section at low energies also, a fact which is attributed to the existence of exactly bound, deuteron-like two-particle states —this, however, requires further investigation. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 6708.

Applications (Strong)

Refer also to abstracts 6712 and 6724.

6738 GROUP THEORY METHODS IN ELEMENTARY PARTICLE PHYSICS. Nagy, Tibor (Lorant Eoetvoes Univ., Budapest). Magy. Fiz. Foly.; 17: 263-344(1969). (In Hungarian).

The usual methods of the field theory do not yield good results in hadron physics because the perturbation calculations cannot be applied successfully for the study of strong interactions. For this reason, special attention has been turned to the examination of the symmetry relations; this approximation is of interest because the strong interactions exhibit many symmetries not found in other interactions. The strong invariance properties make it possible to organize the growing number of experimental data and to establish correlations between physical parameters, such as mass, magnetic moment, transition probabilities etc. The group theory is used to describe the invariance properties of interactions. The fundamentals of the group theory are reviewed in this framework, discussing specifically the structure of SU(2), SU(3), and SU(6) groups, the noncompact symmetries, the $SU(6)_W$ collinear group and the most important results of the quark model, i.e., the correlations between high-energy scattering amplitudes. (TTT)

6739 A UNIFIED FORMULATION OF EFFECTIVE NONLINEAR MESON-BARYON LAGRANGIANS. Chang, Philip Kow-lung. New Haven; Yale Univ. (1968). 105p.
Thesis

A pion-nucleon nonlinear Lagrangian model which is partially invariant under chiral SU(2) ⊗ SU(2) is studied. The π-N and π-π S-wave scattering lengths are calculated. The model is tested by comparing these scattering lengths with those obtained by the current algebra method. A generalized nonlinear model for the baryon-meson system is investigated in the case of no internal

symmetry. The Lagrangian is invariant under SL(4,C) in the absence of the meson mass term. The presence of the symmetry breaking meson mass term allows a generalization of the partially conserved tensorial currents condition (PCTC). The mesons are classified in SU(4) multiplets by including the internal symmetry. A new scheme of tensorial current algebra is formulated which includes the chiral group and covariant SU(6) group as special cases. (Diss. Abstr.)

6740 NUCLEON–NUCLEON T-VIOLATING FORCE AND APPLICATION TO DIRECT REACTION RECIPROCITY EXPERIMENTS. Huffman, Arthur Hurn. Seattle; Univ. of Washington (1968). 139p.

Thesis.

A discussion is presented in connection with time reversal invariance (T). A calculation is given of a nucleon-nucleon T-violating potential resulting from a model in which the basic violation is in the electromagnetic interaction. The conditions of hermiticity and current conservation are applied to choose a T-violating term to go with the T-normal terms of the nucleon electromagnetic current. Since current conservation requires that the T-violating term vanish on the mass shell, the longest range force will come from diagrams of exchange of one photon and one pion. The results in leading nonrelativistic order are three spin-dependent T-violating terms of range roughly equal to the Compton wave length of the pion and of "strength" about 0.1% of the one pion exchange potential. Direct reaction reciprocity tests of time reversal invariance are analyzed on general grounds and specifically with the T-violating force derived above. Robson's theorem that a cutoff DWBA satisfies reciprocity irrespective of T-violation is proved in a simple manner. However, numerical calculations are described which show that Robson's theorem is not a severe restriction on direct reaction reciprocity tests and that the violation of reciprocity is of the same order of magnitude as the ratio of the T-odd to T-normal forces. If the T-violating term of the nucleon current contains an isovector part, the T-odd potential derived in the first part implies about 2% violation of reciprocity in deuteron-stripping. One would therefore expect to have observed a violation in a University of Washington experiment which was carried to a limit of 0.3%. However, if the basic T-violation is isoscalar, the violation of reciprocity would be reduced by a factor of fifty in the context of the model considered. (Diss. Abstr.)

6741 REMARKS ON SPONTANEOUSLY BROKEN SYMMETRIES. Maris, Th. A. J. (Univ. Federal do Rio Grande do Sul, Brazil). Z. Phys.; 229: 392-402(1969). (In German).

Spontaneously broken symmetries are defined and discussed from a qualitative point of view. Common properties and differences with usual symmetries are pointed out. It is stressed that Goldstone's theorem is in many cases not applicable and that therefore the observed approximate hadron symmetries might be interpretable as spontaneously broken ones. Several examples in quantum electrodynamics are given. (auth)

Field Theories

General

6742 CONCIRCULAR SCALAR FIELDS IN SPHERICALLY SYMMETRIC SPACE–TIMES. II. Takeno, Hyoitiro (Hiroshima Univ.). Tensor; 20: 185-96(May 1969).

Concircular scalar fields in the spherically symmetric space–times $S_b(0)$ and $S_c(0)$ are considered using some special spherically symmetric coordinate systems. (J.F.P.)

6743 CONCIRCULAR SCALAR FIELDS IN SPHERICALLY SYMMETRIC SPACE–TIMES. I. Takeno, Hyoitiro (Hiroshima Univ.). Tensor, 20: 167-76(May 1969).

The condition that a spherically symmetric space–time S_b admit a concircular field is investigated, and the condition is expressed in an invariant form by using the theory of characteristic system. Also all concircular fields in all S_b's satisfying the condition are determined. Some properties of these fields are studied. (J.F.P.)

6744 DEGENERATE CASES OF THE EINSTEIN'S CONNECTION IN THE $*g^{\lambda\nu}$-UNIFIED FIELD THEORY. I. Chung, Kyung Tae; Chang, Kun Soo (Yonsei Univ., Seoul). Tensor, 20: 143-9(May 1969).

Conditions for the existence of at least one solution of the Einstein unified field equation expressed in terms of $g^{\lambda\nu}$ are stated. Also the singular solutions $S_{\omega\mu\nu}$ in both holonomic and nonholonomic form are given for all possible indices of inertia. Only two degenerate cases among three possible cases are investigated, that is, the degenerate case of the first and second classes. (J.F.P.)

6745 GAUGE TRANSFORMATIONS AND THE RELATIVISTIC INVARIANCE OF ELECTRODYNAMICS. Oliveira, Colber G.; Vidal, A. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 15: No. 1, 3-20(1969).

A relation is shown to exist between some elements of the group of gauge transformations in electrodynamics and the ten-dimensional Poincaré group. This result is local in structure, that is, it holds at some specified point in the four-dimensional Minkowski space. All properties presently obtained apply to free fields as well as to interacting fields. The generators of the gauge transformations which satisfy the above relation are derived. (auth)

Quantum Field Theory

Refer also to abstracts 6690, 6701, 6710, 6741, and 6768.

6746 (PURC–2137-15) A SEARCH FOR HEAVY MUON BY WIDE-ANGLE μ BREMSSTRAHLUNG AT NAL. Chen, K. W. (Princeton Univ., N. J.). [1969]. Contract AT(30-1)-2137. 22p. Dep. CFSTI.

It is shown that a test of QED in the muon propagator can be performed at NAL with a sensitivity substantially higher than the g-2 experiment. Utilizing a highly collimated μ beam of high intensity ($\sim 10^8$/pulse) and low divergence (<2 mrad), heavy muon mass up to 8 GeV/c^2 can be searched for. In the more conventional description, an upper limit of about 1.0×10^{-15} cm or better on Λ^{-1} could be assigned. The contribution to wide-angle bremsstrahlung from nuclear Compton scattering and inelastic bremsstrahlung need to be carefully investigated but are expected to contribute insignificantly if sufficient care is taken to choose the proper kinematical configuration of the outgoing muon and the gamma ray. (auth)

6747 PROPAGATION OF RADIATION IN A MEDIUM WITH COMPLEX MATRIX ELEMENTS. Beran, M. J. (Univ. of Pennsylvania, Philadelphia). Nuovo Cim.; 64B: 240-54(11 Dec 1969).

The propagation of the radiation intensity, represented by $\mathrm{Tr}\{g a_k^\dagger a_k\}$, in a medium made up of electrons with nonoverlapping wave functions bound at N discrete points is considered. They are bound by a local potential and are subject to a constant external magnetic field. It is found, using perturbation theory to fourth order in the matrix elements, that, if the matrix elements of the electron are real, the intensity for single-mode propagation is unaffected by the unperturbed fourth-order coherence function, $\mathrm{Tr}\{g a_k^\dagger a_k^\dagger a_k a_k\}$. If the elements are complex, however, the intensity is dependent on this function. This result is found in the absence of absorption or stimulated emission as commonly defined and raises the possibility of energy exchange between the radiation field and the static external field. (auth)

6748 VACUUM EXPECTATION VALUE OF THE σ TERM. Genz, H. (Univ., Hamburg). Z. Phys.; 229: 206-8(1969).

Performing the equal-time limit under the integral of the spectral representation for the vacuum expectation value of the current commutator it is shown (as already suggested by models) that the vacuum expectation value of the equal-time commutator of a hermitean charge and the divergence of the corresponding (hermitean) vector or axial vector current ("σ-term") vanishes only if the current is conserved. This then implies that a nonconserved hermitean charge cannot annihilate the vacuum, in agreement with Coleman's theorem. (auth)

6749 FINITE FIELD THEORY AS A DISTRIBUTION PROBLEM. Pfaffelhuber, E. (Univ., Munich). Z. Phys.; 229: 264-77(1969). (In German).

Starting from field equations, asymptotic condition, Wightman functions and using a mathematically correct definition of T-products, a general scheme is developed to yield a divergence-free formulation of quantum field theory. Propagators, Bethe–Salpeter amplitudes, scattering matrix elements, sum rules and equal time commutation relations are discussed. (auth)

6750 ANALYTIC REGULARIZATION IN QUANTUM FIELD THEORY. Guettinger, W. (Univ. of Wyoming, Laramie). Z. Phys.; 229: 329-35(1969).

It is shown how quantum field theories, renormalizable or not, can be rendered finite by means of a residue procedure that realizes analytic regularization and contains the various regularization and renormalization prescriptions as particular cases. The origin of this technique is discussed, some examples are analyzed and recent developments leading to an elimination of the renormalization problem are reviewed. (auth)

6751 REGGE TRAJECTORIES OF THE BETHE–SALPETER EQUATION OF THE WICK–CUTKOSKY MODEL. Mueller, Harald J. W. (American Univ., Beirut). Z. Phys.; 230: 89–94 (1970).

A low-energy perturbation method is used for solving the Bethe–Salpeter equation of the Wick–Cutkosky model in the case of unequal masses. Explicit expansions are obtained for the solutions and Regge parent and daughter trajectories. (auth)

6752 ELECTRODYNAMICS OF VECTOR BOSONS. Caracena, Fernando Jr. Cleveland; Case Western Reserve Univ. (1968). 60p.

Thesis.

A relativistic quantum electrodynamics of charged particles of spin ħ and arbitrary gyromagnetic ratio lacking the severe divergences at high energies that have heretofore characterized such theories is presented. A source of divergence appears in the effective interaction Hamiltonian which ordinarily contains terms that are infinite and noncovariant. Others have circumvented such divergences by using a special limiting process. An alternative method is proposed which is named the polarization formalism because the extra interaction due to the adjustable part of the magnetic moment can be introduced in a natural way as the polarizability of the vacuum due to the vector field. Such terms representing the boson's extra magnetic moment are introduced into the electromagnetic field part of the Lagrangian in a way analogous to the manner in which polarization effects are introduced into the Lagrangian of the electromagnetic field in a material medium. The polarization formalism removes the strong divergences from the theory allowing a further exploration of the high-energy behavior of the electromagnetic interaction; this behavior turns out to be the normal response expected of a charged vector boson with an arbitrary gyromagnetic ratio. When Compton scattering is used diagnostically to study the high-energy behavior as a function of the gyromagnetic ratio, the value of the gyromagnetic ratio, $g = 2$, is found to be unique in reducing the asymptotic dependence of the total Compton cross section as predicted earlier from classical considerations. The Compton cross section then remains bounded even in the limit of infinite energy of the incident photon. This is not true for other values of the gyromagnetic ratio in which case the cross section diverges linearly with energy. (auth)

6753 PERTURBATION EXPANSIONS OF FIELD OPERATORS IN QUANTUM ELECTRODYNAMICS. Bechler, A.; Bialynicki-Birula, I. (Warsaw Univ.). Acta Phys. Pol.; 36: 825–38(Nov 1969).

Expressions for field operators in quantum electrodynamics are given up to the third order of perturbation theory expanded in terms of incoming asymptotic fields. To make the description in the Fock space possible a small photon mass is introduced from the very beginning. It is found that even though this theory is not renormalizable according to the standard criteria, finite field operators $\psi(x)$ and $A_\mu(x)$ can be unambiguously obtained. (auth)

6754 CAUSALITY AND TACHYONS. Thouless, D. J. (Univ. of Birmingham, Eng.). Nature (London; 224: 506(1 Nov 1969).

Reference is made to Bilaniuk and Sudarshan (Nature, 223: 386 (1969)), in which paper textbooks on the special theory of relativity are criticized as purporting to show that causality arguments forbid the existence of faster-than-light particles. The present communication reviews what properties a particle travelling faster than light must possess if it is not to violate the principle that a cause must precede an effect. Such a particle is referred to as a "tachyon"; its velocity is always greater than that of light and increases as the energy is reduced. As the energy tends to zero the velocity increases to infinity, but the momentum is never less than some definite lower limit. As a result of the relativistic law of composition of velocities if there are two frames of reference moving away from one another with velocity u, and a tachyon is moving with velocity v (in the first frame of reference) from the origin of the first frame of reference towards the origin of the second frame, its velocity in the second frame is given by $v' = v-u/1-uv/c^2$. For a tachyon with very low energy, and therefore very high velocity, in the first frame, the velocity in the second frame is $-C^2/u$, and it arrives at the origin of the second frame before it leaves the origin of the first frame, according to the time system of the second frame. Such a tachyon can be interpreted as an antitachyon travelling from the origin of the second frame to the origin of the first frame, and in this way the paradox of arrival at the end of a journey before departure at the beginning disappears. An experiment to test the applicability of the special theory of relativity to tachyons is described. (UK)

6755 MODEL FIELD THEORY IN FIVE DIMENSIONS. Oliveira, Colber G.; Vidal, A. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 15: No. 7, 91-5(1969).

A theory for interacting spin-2, -1, and -0 fields is constructed by 4 + 1 decomposition of a symmetric tensor in five-dimensional flat space. The field equations are a natural consequence of the existing symmetry principles. (auth)

6756 DIRAC'S EQUATION IN A WEYL SPACE. Novello, Mario (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 15: No. 5, 71-9(1969).

Dirac's equation is written in a Weyl space by means of a quaternionic formulation of the Weyl geometry. The so-called minimal-coupling of the electron with the electromagnetic field is an obvious consequence of such a formalism. Mass and charge can be interrelated by an investigation of the theory of massless charged particles embedded in a Weyl space. (auth)

6757 TENSOR FIELDS, GENERATORS OF THE POINCARE GROUP, AND THE DIRAC–SCHWINGER CONDITION. Divgi, D. R.; Woo, C. H. (Univ. of Maryland, College Park). Phys. Rev. Lett.; 23: 1510-13(29 Dec 1969).

Given a conserved tensor field $f_{\mu\nu}(x)$, a simple set of conditions are formulated under which $f_{\mu\nu}$ can be used in place of the symmetric stress-energy tensor $\theta_{\mu\nu}$ to construct the generators of the Poincaré group. A comparison is made with the Dirac–Schwinger condition, and the relevance of the result of Sugawara's theory of currents is discussed. (auth)

Gravitation and General Relativity

Refer also to abstracts 6338 and 6698.

6758 PLANE WAVE SOLUTIONS OF EINSTEIN'S UNIFIED FIELD EQUATIONS OF NONSYMMETRIC THEORIES IN BONDI SPACE–TIME. Lal, K. B.; Ali, Najaf (Gorakhpur Univ., India. M. L. K. Degree Coll., Balrampur, India). Tensor, 20: 130-7 (May 1969).

Following Takeno's concept of plane waves and using the (z-t) property of the waves, the solutions of both the weak and the strong field equations of Einstein's nonsymmetric theories in Bondi space–time were obtained, and it was established that under similar conditions both sets of equations give the same solutions. (auth)

6759 ON SPHERICALLY SYMMETRIC SPACE–TIMES. II. SPACE–TIMES HAVING SOME SPECIAL PROPERTIES. Kitamura, Shin-ichi (Fukui Univ., Japan). Tensor, 20: 197-209(May 1969).

Spherically symmetric space–times of recurrent (spherically symmetric) curvature, those of Ricci recurrent curvature, and those of recurrent conformal curvature are considered. Divergence-free spherically symmetric tensors are treated, especially curvature, conformal curvature, and Ricci tensors. The types of spherically symmetric space–times given by such special tensors are determined. The results are expressed in invariant form in terms of a characteristic system developed previously. (J.F.P.)

6760 ON CONVARIANT SCALAR GREEN FUNCTIONS IN A WEAK GRAVITATIONAL FIELD. Carver, J. R. (Seton Hall Univ., South Orange, N. J.). Ann. Phys. (N.Y.); 55: 301-21(Nov 1969).

By applying the proper-time method to a scalar field in interaction with a weak gravitational field, the coordinate arbitrariness of the linearized gravitational theory is treated as the counterpart of electromagnetic gauge. The calculation of the scalar Green function is developed and shown to possess manifest coordinate-gauge covariance; the explicit contribution of the gauge function isolated by such a procedure is evaluated. A line-integral choice of form for the gauge function when re-expressed in terms of the fields produces the path-dependent Mandelstam line integral upon a change of base gauge. The space-like path averaging of gauge-independent line-integral expressions of the first-order fields does not correspond to a familiar gravitational gauge. Gauge-invariant gravitational potentials are constructed in the case of constant curvature. The exact expression obtained for the corresponding Green function exhibits the expected singularities of the flat space–time case. (auth)

6761 RELATIVITAET UND KOSMOS. RAUM AND ZEIT IN PHYSIK, ASTRONOMIE UND KOSMOLOGIE. (Relativity and the Universe. Space and Time in Physics, Astronomy, and Cosmology). Treder, Hans-Juergen. Wissenschaftliche Taschenbuecher, Band 52. Mathematik und Physik. Berlin, Adademie-Verlag, 1968. 121p. 8.- M.

The discussion covers space and time in various physical dimensions, the Minkowsky universe including Galilei relativity principles and the geometry of the Galilei–Newtonian space–time, Einstein relativity principles, the Lorentz group as a symmetry group in space and time, and the geometrical structure of the Minkowsky universe as structure of causal connections: Riemann–Einstein space including gravitation theory and astronomy, inertia and gravitational forces, the Einstein gravitational equation and the relativistic conservation principle, Einstein space and geometrodynamics, uniform field theory as an extension of gravitation theory, and a comparison of structure of the Minkowsky and the Riemann–Einstein universes; also cosmology and space structure including the principle problem of cosmology, relativistic thermodynamics of the universe and the primary radiation, the cosmological theory of time, and the possibilities of cosmology. (J.F.P.)

6762 TWO-BODY PROBLEM AND GRAVITATIONAL RADIATION. Infeld, L.; Michalska-Trautman, R. (Inst. of Physics, Warsaw). Ann. Phys. (N.Y.); 55: 561-75(Dec 1969).

The damping effect in the motion of two bodies is investigated in the frame of the general theory of relativity. The solution for the field is chosen to approximate an outgoing wave at infinity. The components of the field are evaluated in the required orders of approximation by the Einstein–Infeld–Hoffman method. It is found that gravitational energy radiated from the system is equal to its damping energy loss. The numerical value for the radiated energy agrees with the result predicted by the linearized theory. (auth)

6763 BOUND STATES FOR SPIN ½ PARTICLES IN GENERAL RELATIVITY. Oliveira, C. G.; Arbex, N.; Santoro, A. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 15: No. 4, 55-67(1969).

The problem of bound states for a spin-½ particle interacting with gravitational and electromagnetic fields is treated. These solutions representing the behavior of bound states possess a behavior which is free of inconsistencies both at large values of the distance from the gravitating mass and at small distances. (J.F.P.)

6764 COMPLEX TWO-DIMENSIONAL INTERNAL SPACE IN GENERAL RELATIVITY. Oliveira, Colber G. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 15: No. 3, 35-51(1969).

A calculus of vectors in two-dimensional sympletic spaces is developed from the concept of the existence of local basis systems. The similarities, as well as the differences, of this calculus with the tetrad formulation of four-dimensional curved spaces are discussed. The affinity and curvature of the sympletic space are derived and its relation with the affinity and curvature of the usual spinor formalism is given. A system of hybrid geometrical objects displaying a tensor and a spinor index takes over the role of the usual Hermitian matrices $\sigma_\mu^{KM}(x)$. (auth)

Scattering Theory

Refer also to abstracts 6706 and 6960.

6765 GENERAL EXPANSIONS OF A SCATTERING AMPLITUDE. Feldman, G; Matthews, P. T. (Imperial Coll. of Science and Tech., London). Ann. Phys. (N.Y.); 55: 506-60(Dec 1969).

A general theory of the expansions of a two-particle scattering amplitude is developed based on its Poincaré invariance properties for particles of arbitrary mass and spin. The theory is then applied to the conventional little group expansions, including the 0(3,1) expansion for equal mass, forward scattering; the auxiliary group expansions in terms of 0(3,1) functions for the general case; and the double variable expansions. The implications of poles in these various amplitudes are discussed in connection with high-energy behavior and analyticity at zero momentum transfer. (auth)

6766 ON THE RENORMALIZATION OF FEYNMAN INTEGRALS. Westwater, M. J. (Eidgencessische Technische Hochschule, Zurich). Fortschr. Phys., 17: 1-71(1969).

An arbitrary Feynman integral is considered for external momenta in the Euclidean region, the usual rotation of energy contours having been used to write the integral as an integral over Euclidean internal momenta. A compactification of the space of internal momenta is defined, and the Feynman integral is written as the integral of a current on this compact manifold. This presentation of the integral is used to give a proof of the convergence criterion for Feynman integrals, and to show that a well-defined renormalized integral may be obtained by a subtraction operation or by analytic renormalization. (auth)

6767 INTRODUCTION TO THE QUANTUM THEORY OF SCATTERING. Rodberg, Leonard S.; Thaler, R. M. Pure and Applied Physics. A Series of Monographs and Textbooks. Volume 26. New York; Academic Press Inc. (1967). 407p. $11.50; 107s.

A self-contained and unified development of quantum theory of scattering as it is applied in atomic, nuclear, and high-energy physics is presented. Central ideas and theoretical approaches are emphasized rather than applications. The treatment is entirely nonrelativistic, although many results can be easily generalized to relativistic theory. The wave-packet description of a scattering experiment, differential equation methods, Green functions, integral equations of scattering theory and their solution, operator formalism in two-body scattering, cross sections for general collision processes, the time-dependent approach to scattering theory, the S and K matrices, invariance principle and conservation laws, and spin and angular momentum are covered. (J.F.P.)

6768 ARE REGGE TRAJECTORIES NECESSARILY REAL FOR SPACE-LIKE MOMENTUM TRANSFER. Krolikowski, W. (Inst. for Nuclear Research, Warsaw. Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 17: 509-11(1969).

A formal possibility of avoiding the pole $a(t_j) = j$ in the physical region $t < 0$ by assuming that $a(t)$ for $t < 0$ is not necessarily real is discussed. This discussion also includes the existence and properties of tachyons. (J.F.P.)

6769 EXACT SOLUTION OF THE HALF-SPACE PROBLEM IN SMALL-ANGLE MULTIPLE SCATTERING. Theumann, W. K.; Hemmer, P. C. (Institutt for Teoretisk Fysikk, Trondheim, Norway). Nuovo Cim.; 64B: 255-62(11 Dec 1969).

The back-scattering from a material half-space is studied in the Gaussian small-angle approximation. The exact distribution of angles and displacements of the emerging particles is obtained by relating the problem to a mathematically equivalent Brownian-motion problem, solved recently by McKean. (auth)

6770 SOLUTION OF SINGULAR SCATTERING EQUATIONS BY BOREL SUMMATION. Blomer, R. (Univ., Munich). Z. Phys.; 229: 347-51(1969). (In German).

In the case of zero energy scattering it is shown how to reconstruct the regular solution of a singular scattering equation from an asymptotic (divergent) power series expansion. (auth)

Particle Accelerators

Refer also to abstracts 5900, 6704, 6862, 6947, 7057, and 7074.

6771 (BNL–14202) EMITTANCE MEASUREMENTS IN THE AGS SLOW EXTERNAL BEAM. Blumberg, L. N.; Barton, M. Q.; Fox, J. D.; Glenn, J. W.; Repeta, L. E. (Brookhaven National Lab., Upton, N. Y.). 27 Oct 1969. 36p. Dep. CFSTI.

The emittance of the AGS slow external beam at p = 29.4 GeV/c was calculated from measurements of nearly instantaneous beam profiles as a function of strength of an upstream quadrupole lens. The vertical emittance resulting from a least squares fit to the data is $E_v = .0367\pi$ in.-mrad, approximately twice the predicted adiabatic value. The quality of the fits for these and other data presented do not, however, establish the validity of the elliptical contour assumption used in the data analysis. Average width data for the entire SEB spill duration result in an effective vertical emittance of $E_v = .1148\pi$ in.-mrad. The horizontal SEB data give an emittance of $E_h = .0618\pi$ in.-mrad, about four times the value predicted by theoretical estimates. The time-averaged horizontal emittance is $E_h = .1329\pi$ in.-mrad. The horizontal emittance of the AGS fast external beam was measured to be $E_{h_{FEB}} = .0472\pi$ in.-mrad which is in good agreement with the expected adiabatic value. Data obtained for simultaneous internal and SEB targeting are also reported. The vertical SEB emittance with 50% of the beam interacting on an internal target is $E_{v(SIMULT)} = .0684\pi$ in.-mrad. Corresponding horizontal data were not obtained; however, time-averaged horizontal emittance in the 50% sharing mode gives $E_{h(SIMULT)} = .1545\pi$ in.-mrad, a value not much different from the time-averaged value without sharing. Moreover, additional data show a small variation of horizontal image width as a function of fraction of beam internally interacting and suggests that the horizontal SEB emittance is nearly independent of internal targeting. (auth)

6772 (NAL–32) PROGRESS REPORT ON THE 200-GeV ACCELERATOR OF THE NATIONAL ACCELERATOR LABORATORY. Read, A. Lincoln (National Accelerator Lab., Batavia, Ill. Michigan Univ., Ann Arbor). Aug 1969. Contract AT-(49-8)-3000. 38p. (CONF-690813-6). Dep. CFSTI.

From High Energy Physics Conference, Boulder, Colo.

A review of the principal design features of the 200-GeV accelerator and of the laboratory facilities to be built at the accelerator site, a review of the current status of the design and construction work on the various component subaccelerators which comprise the 200-GeV accelerator, and a brief discussion of the plans which are being developed for experimental facilities and high-energy physics research at NAL are presented. (auth)

6773 (UCRL-19299) BEVATRON OPERATION AND DEVELOPMENT. 62. APRIL-JUNE 1969. Crebbin, Kenneth C. (California Univ., Berkeley. Lawrence Radiation Lab.). 27 Aug 1969. Contract W-7405-eng-48. 10p. Dep. CFSTI.

During the period covered by this report, the Bevatron provided beam for 86.8% of the scheduled operating time. During this period, 2.8×10^{18} protons were accelerated. A maximum beam intensity of 5.2×10^{12} protons per pulse was achieved. Three primary experiments were completed and three new primary experiments were set up. The piston rod of a hydraulic cylinder used in plunging the extraction magnets for the EPB system failed. Also, vertical beam blowup that occurs on flattop when the rf voltage is turned off was correlated to a space-charge phenomenon. (auth)

6774 ION ACCELERATION IN THE ELECTRON BEAM. Plyutto, A. A.; Suladze, K. V.; Temchin, S. M.; Korop, E. D. At. Energ. (USSR); 27: 418-23(Nov 1969). (In Russian).

Some results concerning an investigation of the ion acceleration process in the electron beams are reported. The acceleration of the ion clusters, containing 10^{11} to 10^{12} particles, is to be observed by obtaining powerful electron beams with currents of 10^2 to 10^3 A. The originality of the acceleration process consists in the ion acceleration by means of self-consistent fields, arising in the unstable conditions of forming the current flow and acting in the opposite direction to the outside fields. Maximum energies of accelerated ions can by 10^1 to 10^2 times surpass the voltage applied from outside. An important feature of the acceleration process is independence of ion maximum energies from the charge multiplicity as well as high intensities of self-consistent fields. This means a collective nature of acceleration. High values of maximum ion energies (1×10 MeV) make it possible to use the effect in accelerators. (auth)

6775 ACTIVATION OF AIR NEAR A TARGET BOMBARDED BY 3 GeV PROTONS. Awschalom, M. (National Accelerator Lab., Batavia, Ill.); Larsen, F. L.; Schimmerling, W. Nucl. Instrum. Methods; 75: 93-102(1969).

Measurements of ^{14}O, ^{15}O, ^{13}N, ^{11}C created in air around internal and external accelerator targets are reported for an incident proton energy of 3 GeV and Fe, Pt and Pb targets. For incident proton currents of 10^{11} p/sec, average radionuclide concentrations of 5.4×10^{-9} μCi/cm^3 of ^{13}N and 8.0×10^{-9} μCi/cm^3 of ^{11}C were found in a typical experimental cave. Also, a precision measurement of the ^{11}C-half life is reported as $T_{\frac{1}{2}}$ (^{11}C) = 20.40 ± 0.04 min. (auth)

6776 EVALUATION OF CURRENT-PRODUCED TWO-DIMENSIONAL MAGNETIC FIELDS. Beth, Richard A. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys.; 40: 4782-6(Nov 1969).

Formulas are developed for the two-dimensional magnetic field (and its derivatives of all orders) produced by a long straight conductor of uniform current density. These formulas are independent of whether the field point lies inside or outside the conductor and avoid ambiguities due to multiple values of the complex logarithm. Evaluation of the formulas can be done numerically, with the arbitrary conductor boundary approximated by a polygon, or graphically, or mechanically. (auth)

6777 APPARATUS FOR GENERATING SHORT-PULSE CHARGED-PARTICLE BEAMS. (to Kabushiki Kaisha Hitachi Seisakusho). British Patent 1,170,433. 12 Nov 1969. Priority date 15 Nov 1965, Japan.

A method for generating short-pulse charged-particle beams which employs modified control circuits in the three-electrode method is described. (W.H.K.)

6778 IMPROVEMENTS IN OR RELATING TO PARTICLE ACCELERATORS. McCann, John David; Fuller, Robin Walter Ellecker (to United Kingdom Atomic Energy Authority). British Patent 1,166,053. Oct. 1, 1969. Filed Aug. 8, 1966.

An improved beam exit window arrangement is described. Normally the window is made of a thin sheet of low density metal, such as Mg-Al alloy or Ti, and in passing through the window some energy is lost from the beam and the window becomes heated. Where a high intensity beam is used this can result in the window being heated to the point of mechanical failure. In the arrangement described a laminar flow of gas is directed across the external surface of the window. A pair of coolant channels is located along opposite edges of the window, the gas from one channel flowing across the window and entering the other channel. Large volumes of gas can be used without appreciable quantities passing into the sample region, and furthermore the passage of the gas may result in gases such as ozone and volatiles being drawn from the sample region and entering the coolant channels. The output channel should be maintained at a negative pressure relative to the input channels, by means of pumps. The high pressure gas from the input channel may be directed into an output channel that acts as an expansion chamber; a laminar flow is thereby maintained across the window and the expansion chamber effect results in gases from the sample region being carried away with the cooling gas stream. Gas deflector means may be included. (UK)

6779 CALCULATION OF THE RESIDUAL-PHOTON DOSE RATE INDUCED IN IRON BY 200-MeV PROTONS. Armstrong, T. W. (Oak Ridge National Lab., Tenn.); Barish, J. Nucl. Sci. Eng., 38: 271-2(Dec. 1969).

Protons that stray from the beam of a high-energy proton accelerator can undergo nuclear interactions in the surrounding materials and produce residual nuclei which are radioactive. The photons emitted by such nuclei present a potential radiation hazard after the beam has been shut off. Calculations are presented for the residual photon dose rate induced in iron by 200-MeV protons, and comparisons are made with 3-GeV results reported previously. (W.H.K.)

6780 CALCULATION OF THE RESIDUAL-PHOTON DOSE RATE DUE TO THE ACTIVATION OF CONCRETE BY NEUTRONS FROM A 3-GeV PROTON BEAM IN IRON. Armstrong, T. W. (Oak Ridge National Lab., Tenn.); Barish, J. Nucl. Sci. Eng., 38: 265-70(Dec. 1969).

Calculations were carried out to determine the time dependence of the residual-photon dose rate inside an accelerator tunnel due to a 3-GeV proton beam located on the axis of an iron cylinder. The photon dose rate produced by the activation of the concrete tunnel wall is calculated and combined with the results from a previous calculation for the dose rate contributed by the iron to obtain the total photon dose rate inside the tunnel. The effectiveness of lowering the total photon dose rate by reducing the ^{24}Na production in the concrete is evaluated. The development of the nucleon-meson cascade, the residual nuclei production, and the photon transport are calculated using Monte Carlo methods. (auth)

6781 NEW DEVELOPMENTS IN LIQUID HYDROGEN TARGET SYSTEMS AT THE CAMBRIDGE ELECTRON ACCELERATOR. Hoenig, M. O.; Sonini, H. E.; Russo, C. R. (Harvard Univ., Cambridge, Mass.). Cryogenics; 9: 349-53(Oct 1969).

New developments in liquid hydrogen target systems used in high energy physics research are described. By utilizing mechanical refrigeration, hydrogen is both condensed and maintained as liquid in the cooler system. The development of a novel vacuum-actuated pneumatic-type cryovalve has permitted rapid cycling of the hazardous liquid between a thin walled target chamber and its valved condenser, which thus acts also as a storage tank for the liquid. (auth) (UK)

6782 200 MHz DYNAMIC PHASEMETER: PHASE MEASUREMENT INSIDE CAVITIES OF THE NEW 20 MeV INJECTOR OF SATURN. Crenn, J. P.; Duprez, R. (CEA, Saclay, France). Onde Elec.; 49: 971-6(Oct 1969). (In French).

The present 3.7 MeV Van de Graaff injector of Saturn will be soon replaced by a 20 MeV proton accelerator. Injection beam energy is modulated by a 200 MHz cavity with variable phase. The dephaser is driven by a sharp (±1°) dynamic phasemeter measuring 180° phase shift into 600 μs. Measurement is operated with quantified standard phase shifter, phase detector, and control and counting logics. (auth)

6783 NUCLEON TRANSPORT AT ENERGIES UP TO 10^4 GeV. O'Brien, Keran (Atomic Energy Commission, New York). Trans. Amer. Nucl. Soc., 12: 969-70(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6784 LOS ALAMOS MESON PHYSICS FACILITY HOT CELL COMPLEX. Wilson, Mahlon T. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 851(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6785 COMPACT SERVO MASTER-SLAVE MANIPULATOR WITH OPTIMIZED COMMUNICATION LINKS. Flatau, Carl R. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 855-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6786 SEMIEMPIRICAL DETERMINATION OF ELECTRON SPECTRA USING DYNAMIC PROGRAMMING METHODS. Ash, M. (McDonnell Douglas Astronautics Corp., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 12: 941-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6787 TRACE: AN ON-LINE BEAM TRANSPORT DESIGN PROGRAM. Colonias, J. S. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 76: 13-22(1969).

The application of computer graphics in the design of beam transport systems is described. A computer program called TRACE is introduced which allows the user to design beam transport systems interactively with a computer through a display console, light pen, and teletype. The computer environment and its relation to program TRACE are briefly described. A discussion on the operation of the program is presented with an example. (auth)

6788 WIRE ORBIT RAY TRACING OF MAGNETS USING MAGNETOSTRICTIVE WIRE CHAMBER TECHNIQUES. Prescott, C. Y.; Cheng, S. U.; McDonald, K. T. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Nucl. Instrum. Methods; 76: 173-6(1969).

A method for precise momentum calibration of magnets which combines the well-known floating-wire technique of tracing particle orbits through magnetic fields and electronic readout using magnetostrictive delay lines similar to those used in wire spark chambers is briefly described. The advantage of this method lies in the rapid and accurate measurement of many particle trajectories in a relatively short period of time. The use of magnetostrictive readout electronics eliminates the tedious work of measuring individual trajectories optically, and provides means by which the procedure can be computer controlled. (auth)

6789 MOYER INTEGRALS FOR ESTIMATING SHIELDING OF HIGH-ENERGY ACCELERATORS. Routti, J. T. (Univ. of California, Berkeley); Thomas, R. H. Nucl. Instrum. Methods; 76: 157-63(1969).

Integrals of the form $\int_0^{\pi} \exp(-\beta\theta) \exp(-1 \operatorname{cosec} \theta) d\theta$ often arise in the calculation of shielding for high-energy accelerators. These integrals have been named Moyer Integrals and numerically evaluated in the region of practical interest. Examples are given to show how these integrals may be used to estimate shielding in practical situations. (auth)

6790 SIMPLE TARGET BIASING SYSTEM. Neilson, G. C.; Panar, J. D.; Holm, L. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods; 76: 75-6(1969).

A simple target biasing system operated by controlling the leakage current from the target to ground is described. With this method the beam current on target can be measured. (auth)

6791 COIL CIRCUIT FOR MOVING THE ORBIT OF ELECTRONS IN A BETATRON, ETC. Hattori, Hiroyuki (to Shimazu Seisdakusho Ltd.). Japanese Patent 1969-15837. 8 Jul 1969. Filed 9 Nov 1965.

An improvement is made on coil circuits for moving the orbit of electrons in a betatron. The voltage, occurring when pulsed current is applied for movement of electron beam, is lowered, and adverse effects on other components are reduced. Compared with the conventional method, the insulation of coils is rendered easy, and damage of the grounding terminal for the conducting film due to the flow of a large current between the film and earth is eliminated. Furthermore, induction into other coils is minimized, thereby stability of the betatron as a whole is increased. Coils for movement of the orbit of electrons, which are wound in opposite directions, are installed on a pair of central magnetic poles. The neutral point of the coils is grounded. When pulsed current flows, the terminal voltages of the coils are made into a specific ratio obtained when the coil terminal voltages are earthed only on one side. (NSA of Japan)

6792 PARTICLE ACCELERATOR. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1969-15836. 8 Jul 1969. Filed 24 Nov 1965.

In the particle accelerator proposed, a high-intensity ion beam is obtained by cooling the accelerating electrodes. The method removes the drawbacks such as deterioration of a filament, internal discharges, and deterioration of bonds, packings, etc. in the conventional accelerator, caused by temperature rise due to evolved gases. The particle accelerator consists of a particle source, an accelerating tube through which particles are accelerated, the accelerating electrodes arranged along the length of the accelerating tube, a target, and means to cool the respective accelerating electrodes. To cool the electrodes, piping is attached to the electrodes, either outside or inside of the accelerating tube. Or instead, the accelerating electrodes themselves may be made to include cavities for coolant flow. (NSA of Japan)

6793 SUPPORT FOR MAGNET OF PARTICLE ACCELERATOR LIKE BETATRON. Kaneko, Takeo (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-15838. 8 Jul 1969. Filed 17 Nov 1965.

A support structure for the magnet of a medical betatron is described. The betatron itself is rotated or oscillated for good irradiation of the lesion. The method has the advantages of high mechanical strength, good magnetic characteristics easy construction, and low cost. It includes the following: a circular accelerating tube; pole pieces wound with exciting coils; two long plate yokes running in parallel, sandwiching the circular accelerating tube; reinforcing members of a non-magnetic material (i.e., stainless steel), and flattened U shape in cross section which hold together the two yoke plates at the ends (this also improves magnetic characteristic of the magnet yokes); a two-pronged body, to its top ends the two yoke plates are fixed through the reinforcing members; and a means to rotate the betatron as a whole around the axis of the pronged body. (NSA of Japan)

6794 POWER-SOURCE DEVICE FOR ELECTROMAGNETS OF PARTICLE ACCELERATOR. Takei, Fumio (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-18638. 14 Aug 1969. Filed 12 Aug 1965.

An improvement is made on the power source for exciting the electromagnets in a particle accelerator (such as the synchrotron) which deflects and accelerates the beam of electrons or protons in a circular orbit. The power-source device consists of the following: a main power-source device for the excitation; the main coils of the electromagnets for keeping the charged-particle beam in a constant orbit; condensers forming resonance circuits with the main coils, connected to the main coils and the power source circuits either in series or in parallel; saturable reactors inserted in the resonance circuits, which are in saturation for normal current through the main coils, and in unsaturation for the current near the negative and positive maxima; bias coils wound around a part of the electromagnets; and a current-source device, connected to either the power-source or exciting power-source device, by which bias dc is supplied to the electromagnets. The excitation of the electromagnets is increased and decreased in a relatively short period, and a flat wave-form is obtained near the maximum in the magnetic-flux wave. (NSA of Japan)

6795 PARTICLE ACCELERATOR. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1969-17120. 23 Jul 1969. Filed 9 Jul 1965.

A particle accelerator is proposed composed of a high-voltage electrode and ion source, a series of accelerating electrodes, and a target. This horizontal arrangement of accelerator components is held by an upright plate on a truck. A high-voltage cable connects a high-voltage power source to the electrode and ion source. The advantage is prevention of surface flash due to uniformity of potential gradient on the surface of the high-voltage cable between the upright plate and the high-voltage electrode. Over the length of the high-voltage cable, to the part of accelerating electrodes, a plurality of conducting rings are set around the cable at appropriate positions. The same potentials are applied to these rings as to the respective accelerating electrodes. (NSA of Japan)

6796 EXPERIMENTAL RESEARCH ON PROTON DYNAMICS IN STRONG-FOCUSING LINEAR ACCELERATOR. Batalin, V. A.; Kapchinskii, I. M.; Plotnikov, V. K. At. Energ. (USSR); 27: 428-31(Nov 1969). (In Russian).

The data of the momentum spread of particles for large and small beam currents in different operation conditions of the linac injector of the ITEP proton synchrotron are given. In the optimum condition for beam current 100 to 120 mA the momentum spread doesn't exceed 0.85%. Methods of measurement and evaluation of spectra are described. Experimental data obtained are compared with theoretical estimates. The question on the dependence of the beam energy spectrum on the acceleration conditions is discussed. (auth)

6797 MULTIPURPOSE CIRCUIT FOR MAGNETIC FIELD CORRECTION IN HIGH ENERGY SYNCHROTRONS. Karabekov, I. P. At. Energ. (USSR); 27: 424-8(Nov 1969). (In Russian).

A multipurpose circuit for magnetic field corrections at different stages of the acceleration cycle is presented. A method of monitoring the beam position during the first turn to an accuracy of not less than ±0.1 mm is developed. This allows to correct the magnetic field in the magnet flock to the accuracy of 0.01 to 0.03% at the level of the injection field. A procedure for such correction

of the flocks based on the data concerning the beam is proposed. Some considerations on improvement of the orbit alignment and increase in operating capacity of the system for compensation of hazardous space field harmonics according to beam information is also given. (auth)

6798 IRRADIATION DEVICE. Toda, Tetsuo. (Mitsubishi Electric Corp.). Japanese Patent 1969-19999. 27 Aug. 1969. Filed 15 Dec 1965.

The device proposed is for irradiating an object, by means of a rotating arm, e.g., in medical therapy. The advantages are compactness of the irradiation device, and easy rotation of the arm. The irradiation device in general includes a base; a rotating arm in the form of a crank, installed on the base; and an object of irradiation at a suitable position. A particle source is in the arm near the end where the arm is installed on the base. Immediately following the source, the first accelerating section is installed along the axis of the arm. Then, the accelerated beam is bent 90° by an electromagnetic deflecting method within the arm, into the other part of the arm. Along this axis, the second accelerating section is installed. Finally, at the end of this part, the accelerated beam is bent 90° again toward the object of irradiation. Whereas in the conventional device the whole acceleration is done only along one axis, in the proposed device, the acceleration is divided in the two sections, and the advantages mentioned in the beginning are obtained. (NSA of Japan)

6799 X-RAY IRRADIATION DEVICE. Maekawa, Akiji (to Hitachi Ltd.). Japanese Patent 1969-18636. 14 Aug 1969. Filed 17 Sep 1965.

An irradiation system is described for either low-energy or high-energy x ray production. For low-energy x ray production, the electron gun and a three-electrode structure accelerate the electrons to a low-energy target. For high-energy x ray production, the electron gun and three-electrode structure act as the electron source for a linear accelerator which accelerates the electrons to high energies on an appropriate target. (TSS) (NSA of Japan)

6800 ELECTRON GUN ABLE TO DEFLECT THE ELECTRON BEAM FOR USE IN A BETATRON. Ito, Tadashi (to Shimadzu Seisakusho Ltd.). Japanese Patent 1969-19998. 27 Aug 1969. Filed 20 Sept 1965.

The electron gun, able to deflect electron beam, for use in a betatron, has the advantages of small voltage requirements for the deflection, elimination of the scattering of electrons, and the voltage-withstanding quality is improved. The deflection of 1 to 2°, for example, is possible with a low voltage of about 1000 V. The focusing electrode, in the form of U, in which an electron-emitting filament is located, consists of two upper and lower sections, with an insulation between the two. In front of the open end of the focusing electrode, is an anode. To deflect the electron beam from the filament, different voltages are applied to the upper and the lower section of the focusing electrode. In this way, the required voltages are low, since the deflection is done before acceleration. (NSA of Japan)

6801 PARTICLE ACCELERATOR WITH PULSED OUTPUT. Haga Yoshio (to Mitsubishi Heavy Industries). Japanese Patent 1969-18637. 14 Aug 1969. Filed 15 Sep 1965.

In the linear particle accelerator with pulsed output, the stabilization of the time average of the charged-particle beams is achieved. The electron beam or x-ray is detected and compared with the set value, and the output frequency of trigger oscillator is so controlled as to make the difference zero. Further, by setting the allowable ranges for the output of both the accelerator itself and the trigger oscillator, when these values are exceeded, the operation of the particle accelerator is suspended. The particle accelerator with pulsed output includes the following: a trigger oscillator to control the pulsed power source; a means to control the oscillating frequency of the trigger oscillator to make the difference between the detected accelerator output and the set value zero; a means to suspend the operation of the accelerator when the trigger-oscillator frequency exceeds the set value; and a means to suspend the accelerator operation when the accelerator output is out of the automatic adjustment range of output. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 5940, 6030, 6576, 6581, 7266, 7270, 7271, 7276, 7299, 7302, 7303, and 7352.

6802 (CISE-R-124) SYSTEMATIC APPROXIMATIONS OF FIRST-COLLISION PROBABILITIES. Topical Report No. 1. Bonalumi, R. (Centro Informazioni Studi Esperienze, Milan (Italy)). July 1964. Contract 006-64-4-NTRI. 61p. Dep. CFSTI (U. S. Sales Only).

Some methods systematizing the approximate calculation of some collision probabilities of interest are described. In particular: a general method is found for calculating self-collision probabilities in non-circular cylinders; rather a general, and very simple, approximation to some transport integrals is proposed and successfully tested; a general method for evaluating self-collision probabilities in multiply connected regions is proposed; a method is eventually given for the evaluation of interaction probabilities inside a cluster. The last method is a critical revision of a model suggested by other authors, but with some important modifications to avoid simplifying the problem more than is actually allowed when some comparisons with exact calculations are taken into account. (auth)

6803 THE EFFECT OF CHEMICAL BINDING ON THE NEUTRON CROSS SECTION OF TANTALUM HYDRIDE. Brand, K. (Institut fuer Reine und Angewandte Kernphysik, Kiel). Atomkernenergie, 14: 449(Nov.-Dec. 1969).

The total neutron cross section was measured at room temperature with the crystal spectrometer at the FRG-1. The energy range was from 0.073 to 0.727 eV and the resolution between 1 and 5%. The data exhibit well separated optical levels at 0.126 ± 0.002 and 0.158 ± 0.003 eV. Both are attributed to the 0 – 1 transition of hydrogen atoms in the metal lattice. Another level (0 – 2 transition) was observed at 0.354 ± 0.009 eV. The double exited state of the ground state at 0.126 eV is indicated weakly at about 0.260 eV. (auth)

6804 NUMBER OF POSSIBILITIES IN NEUTRON OPTICS. Matora, I. M. At. Energ. (USSR), 27: 71-3(July 1969). (In Russian).

Experiments with the deflection of polarized neutron beams in an inhomogeneous magnetic field showed that a nonpolarized neutron beam also has a clear tendency to separate into two parts after passage of the beam through a steep-gradient magnetic field. The neutrons in the two beams will be polarized in opposite directions. This unit can be used for polarization of slow neutrons. With the introduction of improvements in the optical properties of the magnet used to split the initial beam it is also possible to obtain neutrons which have been focused and spatially separated according to neutron energy in addition to polarization of neutrons. Equations are given for the radial motion of neutrons in the field of a magnet. Half the neutrons undergo double focusing, and the other half double defocusing in the magnet. The neutron focal distance is determined by its energy. The energy resolution of the system can be very high. Vacuum would be required in the equipment. At present it is possible to create an inhomogeneous magnetic field with a constant gradient which is equivalent to 10 times the force of gravity in increasing the kinetic energy of the neutron. Thus, in a vertical gap of 12 cm the neutrons which are attracted to the earth by magnetic and gravitational fields will have an acceleration of 11 g. Thus it is possible to decrease the size of a magnetic-gravitational refractometer by an order of magnitude as compared with a gravitational refractometer by itself. (TTT)

6805 DIFFUSION IN NONLINEAR MULTIPLICATIVE MEDIA. Canosa, Jose (IBM Scientific Center, Palo Alto, Calif.). J. Math. Phys. (N. Y.), 10: 1862-8(Oct. 1969).

The time-dependent behavior of the nonlinear distributions defined by the diffusion equation with several nonlinear source terms is studied. The nonlinear diffusion equation is solved by an eigenfunction-expansion method, which is in principle independent of geometry or number of dimensions. The qualitative time behavior of the distributions and their steady states can be ascertained from a simple analysis of the fundamental mode approximation only. Explicit solutions are presented in one- and two-dimensional geometries. (auth)

6806 CONTINUOUS EIGENVALUES IN NEUTRON THERMALIZATION. Tokizawa, Masamichi (Chuo Univ., Tokyo). J. Math. Phys. (N. Y.), 10: 1834-41(Oct. 1969).

The continuous eigenvalue spectra of the linearized Boltzmann operator describing the energy distribution of neutrons in an infinite Einstein crystal are studied. This operator consists of two terms: a multiplication operator and an integral operator with δ-function-type singular kernel. The eigenvalue problem is transformed into the solution of an inhomogeneous integral equation by applying Case's method on the one-velocity transport equation. The existence of the solution of the integral equation is examined by the Neumann-series expansion. It is found that for sufficiently low temperature the range of numerical values of the multiplication operator forms the continuous eigenvalue spectra of the Boltzmann operator and the corresponding eigenfunctions are of δ-function type. (auth)

6807 PROSPECTS FOR ENHANCING THE NEUTRON OUTPUT OF SEALED NEUTRON TUBES. Ab, E. A.; Pechorin, V. P.; Khutsishvili, L. A. Geofiz. App.; No. 36, 99-104(1968). (In Russian).

This paper examines the causes of discrepancy between values of neutron output in portable sealed accelerators and special stationary accelerators. The relative effect of this discrepancy is analyzed and recommendations are made in connection with increasing the neutron output of the portable sealed accelerator tubes to a level approaching that of the stationary generators. (Geophys. Abstr.)

6808 FEATURES OF THE APPLICATION OF UNG-2 ACCELERATING TUBES IN BOREHOLE NEUTRON GENERATORS. Ivanov, V. F.; Lyubavin, Yu. P.; Tyvin, L. I. Geofiz. App., No. 36, 88-95(1968). (In Russian).

The conditions under which the UNG-2 accelerating tubes can be used in borehole neutron generators of multipurpose design are described. On the basis of an analysis of experimental data and of the physical and electrical characteristics of these tubes, recommendations are made concerning the choice of operating regime of the neutron generator with minimum possible regulation and concerning the order of connecting the tubes. (Geophys. Abstr.)

6809 MASS SPECTROMETRIC CHARACTERISTICS OF ION SOURCES OF SEALED GAS-FILLED ACCELERATING NEUTRON TUBES. Ab, E. A.; Pechorin, V. P. Geofiz. App., No. 36, 95-8(1968). (In Russian).

This paper describes the results of mass spectrometric measurements which make it possible to establish the ionic composition of ion sources of various types, and variations in that composition arising upon change in the conditions of supply. (Geophys. Abstr.)

6810 MEASUREMENT AND ANALYSIS OF FAST-NEUTRON SPECTRA IN IRON. Malaviya, B. K.; Kaushal, N. N.; Mallen, A.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 12: 940-1(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6811 TIME-OF-FLIGHT MEASUREMENTS OF FAST-NEUTRON SPECTRA IN ALUMINUM. Malaviya, B. K.; Kaushal, N. N.; Golay, M. W.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 12: 756-7(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6812 NEW METHOD FOR MEASUREMENT OF NEUTRON SCATTERING CROSS SECTIONS. Albert, T. E. (Martin-Marietta Corp., Orlando, Fla.); Carroll, E. E. Trans. Amer. Nucl. Soc., 12: 745-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6813 IMPROVED THEORETICAL CROSS SECTION FOR POLYETHYLENE. Kirouac, G. J.; Jernow, S. K.; Moore, W. E.; Esch, L. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 12: 672-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6814 COMPARISON OF TWO EXACT TRANSPORT THEORY METHODS. Lewis, E. E. (Northwestern Univ., Evanston, Ill.). Trans. Amer. Nucl. Soc., 12: 428-9(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6815 THERMAL-NEUTRON SCATTERING IN WATER. Jarvis, R. G.; Thorson, I. M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 12: 673-4(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6816 OPTIMIZATION OF EXPERIMENT PARAMETERS IN EXPONENTIAL TIME-DECAY EXPERIMENTS. Bull, Stanley R.; Lu, Kau Ki (Univ. of Missouri, Columbia). Trans. Amer. Nucl. Soc., 12: 675(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6817 NEUTRON DIFFRACTION BY A VIBRATING CRYSTAL. Englehart, Richard W.; Jacobs, Alan M. (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc., 12: 520-1(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6818 A METHOD FOR THE PRODUCTION OF NEUTRONS IN THE FORM OF PULSES. Langer, Philippe; Rabeau, Maxime (to Commissariat a l'Energie Atomique). British Patent 1,173,874. 10 Dec 1969. Priority date 12 Jan 1967, France.

A pulsed neutron source which produces fluxes up to 10^{17} n/cm^2/s is described. The source produces neutrons by the T(d,n)^{4}He or the D(d,n)^{3}He reaction and utilizes a laser-bombarded electrode for production of the deuteron beam. (W.H.K.)

6819 IMPROVEMENTS IN OR RELATING TO NEUTRON GENERATORS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,173,450. 10 Dec 1969. Priority date 12 Aug 1966, Germany.

The design of a pulsed neutron source using the T(d,n) reaction is presented. Improved output is achieved using a seven-electrode duoplasmatron source for producing seven deuteron beams for bombardment of the tritium target. (W.H.K.)

6820 NEUTRON DIFFUSION ACROSS A MEDIUM DISCONTINUITY. Trikha, S. K. (Univ. of Delhi); Kothari, L. S.; Goyal, I. C. J. Nucl. Energy 23: 505-16(1969).

Calculations on the diffusion of neutrons across a medium discontinuity in crystalline moderators—graphite and Be are reported. Using plane geometry, with the first slab of finite thickness and the second one extending to infinity, the steady state neutron spectra at different space points are calculated. The temperature of both the media is kept the same. Starting from an equilibrium distribution in the first medium (of finite thickness) it is found that the equilibrium is disturbed as the interface is approached and in the second medium it is only at considerable distance from the interface that equilibrium is again re-established. This distance around which equilibrium is re-established depends upon the moderator used, but increases rapidly as the temperature of the whole system is reduced. Diffusion lengths of neutrons in the two media at various temperatures are reported. (auth) (UK)

6821 S- AND P-WAVE NEUTRON SPECTROSCOPY. XII. HIGHER RESOLUTION TECHNIQUES IN THE keV REGION WITH WINDOWLESS GAS TARGETS. Beard, P. M.; Parks, P. B.; Bilpuch, E. G.; Newson, H. W. (Duke Univ., Durham, N. C.). Ann. Phys. (N. Y.), 54: 566-97(Oct. 1, 1969).

The relative total yield of the ^{18}O(p,n) reaction was studied from threshold to 3.290 MeV with a proton resolution of about 1/11,000. A previously unreported resonance was observed and improved values of widths and energies were obtained for the other resonances. The Q value for the reaction was determined to be -2439 ± 1 keV which places threshold at 2576 ± 1 keV. The reaction took place in the windowless cryogenic target chamber. A gas handling system was developed to allow one liter of oxygen gas, 65% enriched in ^{18}O, to be cycled through the target chamber and recovered with a minimum of loss or dilution. The ^{18}O(p,n) neutrons were used in a series of transmission measurements to test the resolution capability of the gas target as a neutron source. Results were in good agreement with resolution predictions. Total neutron energy spreads were 250 and 500 eV at neutron energies of 30 and 525 keV, respectively. (auth)

Nuclear Properties and Reactions, A≤5

Refer also to abstracts 6686, 6948, and 6956.

6822 (IF-69-51) THE SECOND-ORDER CORRECTION OF THE PERTURBATION THEORY TO THE VARIATIONAL BINDING ENERGY ^{3}H AND ^{4}He. Filippov, G. F.; Maksimenko, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 13p. (In Russian). (CONF-690632-3). Dep. CFSTI (U. S. Sales Only).

From Conference on the Theory of Small-Nucleon Systems, Kiev, USSR.

A general expression for the second-order correction of perturbation theory to the binding energy of the system of four nucleons defined by the variation method is found. This expression is used for calculations in case of the concrete variants of the pair potential of two bodies found in the problem. (auth)

6823 ELASTIC SCATTERING OF 166 MeV ALPHA PARTICLES ON D, C, Si, Sn, AND Pb. Brissaud, I.; Brussel, M. K.; Sowinski, M.; Tatischeff, B. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., 30B: 324-6(Oct. 27, 1969).

Results for the elastic scattering of 166 MeV α-particles on the nuclei D, C, Si, Sn and Pb are presented. The results are interpreted with the optical model. (auth)

6824 THREE NUCLEON CALCULATIONS WITH LOCAL TENSOR FORCES. Malfliet, R. A. (Univ. of Utrecht); Tjon, J. A. Phys. Lett., 30B: 293-5(Oct. 27, 1969).

Within the framework of the Faddeev equations, the triton binding energy, Coulomb energy, S'- and D-state probabilities are determined. The two-particle interactions thereby employed are of the local Yukawa type and include also tensor forces. (auth)

6825 $p + D \rightarrow p + p + n$ REACTION AT $6.5 \leq E_p \leq 13$ MeV. Niller, A.; Joseph, C.; Valkovic, V.; von Witsch, W.; Phillips, G. C. (Rice Univ., Houston, Tex.). Phys. Rev., 182: 1083-94 (June 20, 1969).

The D(p,2p)n reaction was studied in a kinematically complete experiment at proton bombarding energies of 6.5 to 13.0 MeV. Silicon surface-barrier detectors were used to record coincident proton-energy spectra at the two sets of angles $\theta_1 = 30°$, $\theta_2 = 30°$ and $\theta_1 = 30°$, $\theta_2 = \theta_p$, where θ_1 and θ_2 are on opposite sides of the beam axis and θ_p is the proton angle corresponding to an n-p system with low relative energy recoiling at $\theta_1 = 30°$. The spectra at $\theta_1 = 30°$, $\theta_2 = 30°$ were dominated by the direct knockout or quasi-free mechanism and the spectra at $\theta_1 = 30°$, $\theta_2 = \theta_p$ were dominated by the two-step sequential decay mechanism $p + D \rightarrow p + d^* \rightarrow p + p + n$, where d^* is a short-lived particle composed of a neutron and a proton in a $^1S_0$ configuration. The Kuckes-Wilson-Cooper form of the spectator-model calculation gives a good qualitative fit to the knockout data. A least-squares fit of three forms of the density-of-states function to the $E_p = 11$ MeV, $\theta_1 = 30°$, $\theta_p = 77°$ data gave the best result with the renormalized density-of-state function. Including the statistically most significant, independently measured spectra at bombarding energies of 9, 11, 12, and 13 MeV, a neutron-proton singlet scattering length of -23.9 ± 0.8 fm is obtained. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 5905, 6706, 6775, 6821, 6823, 6953, and 6957.

6826 (IAE-1764) EXCITATION OF ANALOG STATES WITH $T = 3/2$ IN THE REACTION (^{3}He,n). Brill, O. D.; Vongai, A. D.; Ogloblin, A. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1969. 6p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The two-nucleon transfer reaction is an effective means for the excitation of analog states with $T = 3/2$. The as yet uninvestigated (^{3}He,n) reaction was studied for this purpose. The study involved measurement of the neutron spectra obtained in the (^{3}He,n) reactions on ^{9}Be, ^{13}C and ^{25}Mg to search for unknown $T = 3/2$ levels in the ^{11}C, ^{15}O and ^{21}Si nuclei. The ^{27}Al(^{3}He,n)^{29}P reaction was also investigated to verify its selectivity with respect to the excitation of the known $T = 3/2$ level in the ^{29}P nucleus. The targets were irradiated with an 11.6- and 16.1-MeV ^{3}He beam. The neutron spectra were determined by the time-of-flight method. The results indicated that the (^{3}He,n) reaction acts selectively in the excitation of analog states. The angular distribution of the neutrons was also determined to provide additional indentification of the observed $T = 3/2$ levels. (TTT)

6827 (INSJ-111) LIST OF MEMBERS OF QUASI-GROUND, QUASI-BETA AND QUASI-GAMMA BANDS. Sakai, Mitsuo (Tokyo Univ. (Japan). Inst. for Nuclear Study). Sept. 7, 1969. 33p. Dep. CFSTI (U. S. Sales Only).

Excited levels in even-even nuclei are classified into so-called quasi-ground, quasi-beta and quasi-gamma bands. Newly revised compilation of experimental data is presented. (auth)

6828 (KFK-997) VECTOR POLARIZATION OF DEUTERONS BY THE ELASTIC SCATTERING OF ^{12}C BETWEEN

41 AND 51 MeV. Seibt, E.; Weddigen, Ch.; Weigele, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Mar. 1969. 19p. (In German). (CONF-690326-2). Dep. CFSTI (U. S. Sales Only).

From Spring Conference of the Committee on Nuclear Physics of the German Physical Society, Freudenstadt, Germany.

Double scattered deuterons give an azimuthal asymmetry of the form $1 + A \cos \phi + B \cos 2\phi$. The asymmetry parameters A and B were taken for double scattering of 51-MeV deuterons on carbon as a function of primary and secondary polar scattering angles. No significant values for B could be found. Thus, a calibration experiment for vector polarization iT_{11} could be performed. iT_{11} is given for deuteron energies from 41 to 51 MeV and polar scattering angles from 15 to 58°CM. Comparison with some optical model calculations give only qualitative agreement. (auth)

6829 (UCRL-19348) DOPPLER BROADENING OF THE 6.322-MeV γ RAY FROM ^{15}N FOLLOWING μ^- CAPTURE IN ^{16}O. Kaplan, S. N.; Pyle, R. V.; Temple, L. E.; Valby, G. F. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1969. Contract W-7405-eng-48. 3p. (CONF-690503-7). Dep. CFSTI.

From 3rd International Conference on High Energy Physics and Nuclear Structure, Argonne, Ill.

The 6.322-MeV line from ^{15}N is fitted by a simple kinematic model by using the neutron energy spectra predicted in resonance-capture calculations of Raphael, Uberall, and Werntz (Phys. Letters, 24B: 15(1967)). (J.W.R.)

6830 MATHEMATICAL PROBLEM OF 6 PARTICLES WITH GAUSSIAN INTERACTIONS. Salem, S. M. (Alexandria Univ., Egypt). Nuovo Cim., 63B: 625-37(Oct. 11, 1969).

A differential-equation method is used to investigate the energy levels of ^6Li. The interaction assumed has a Gaussian radial dependence and contains central and tensor forces of equal range, the latter force being responsible for the splitting of the D-multiplet. The wave functions are expressed as linear combinations of the products of the multidimensional radial and surface harmonic parts. The radial parts (depending upon the nuclear radius) are allowed to take the best form by minimizing the total energy. The calculations for the splitting between the $^3S_1$ and $^3D_3$ levels, and between the $^3D_2$ and $^3D_1$ levels agree reasonably with the experimental data, the splitting between the $^3D_3$ and $^3D_2$ levels, apart from being only about 20 percent of the observed value, is also predicted to be in the wrong direction. (auth)

6831 THE $^{16}O(d,n)^{17}F$ REACTION AT E_d = 8.0 AND 9.3 MeV. Thornton, S. T. (Univ. of Wisconsin, Madison). Nucl. Phys., A137: 531-44(1969).

The reaction $^{16}O(d,n)^{17}F$ was investigated by the neutron time-of-flight method at E_d = 8.0 and 9.3 MeV. Absolute angular distributions were obtained for the transitions to the ground and first excited states in ^{17}F. Excited states in ^{17}F at E_x = 3.10 and 3.86 MeV were identified. No evidence was found in ^{17}F for the mirror level of the 5.22 MeV state in ^{17}O. The distorted wave method analysis of $^{16}O(d,p)^{17}O$ and $^{16}O(d,n)^{17}F$ ground state and first excited state transitions yielded spectroscopic factors near 0.9. (auth)

6832 THE 3576 AND 3616 keV STATES IN ^{18}Ne. Rolfs, C.; Trost, W.; Riess, F.; Kramer, R.; Kuhlmann, E. (Univ., Freiburg i. B.). Nucl. Phys., A137: 481-6(1969).

The existence of the 3576-keV state in ^{18}Ne is confirmed by an $n-\gamma-\gamma$ coincidence experiment in the reaction $^{16}O(^3He,n\gamma)^{18}Ne$. The 3616-keV state has a 7 ± 2% ground state transition branch. (auth)

6833 ELECTROPRODUCTION OF PIONS ON ^{12}C NUCLEI. Titov, Yu. I.; Stepula, E. V.; Akhmerov, R. V.; Byvalin, S. A.; Severin, N. F.; Smelov, E. M.; Yaroshevskii, L. D. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 9: 1326-7(June 1969). (In Russian).

The spectrum of inelastically scattered electrons on a nucleus carries information on the electromagnetic interaction and the structure of the nucleus. Preliminary results are presented on the spectrum of inelastically scattered electrons of ^{12}C at energies of 400 to 1100 MeV with an initial energy of 1126 MeV. Two maxima are visible at an angle of 25°. One of the maxima corresponds to a quasielastic electron scattering on ^{12}C nuclei. The other is caused mostly by the production of pions on ^{12}C nuclei. Above the threshold of pion production, the inelastic scattering cross section is in great part caused by excitation of the first pion-nucleon resonance. (TTT)

6834 CROSS SECTION FOR THE DELAYED-NEUTRON YIELD FROM THE $^{17}O(n,p)^{17}N$ REACTION AT 14.1 MeV. Menlove, H. O.; Auguston, R. H.; Henry, C. N. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 742(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6835 HIGH-RESOLUTION CARBON TOTAL-NEUTRON CROSS-SECTION MEASUREMENTS. Knowlen, R. B.; O'Dell, A. A. (Edgerton, Germeshausen and Grier, Inc., Goleta, Calif.). Trans. Amer. Nucl. Soc., 12: 924(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6836 A STUDY OF $^{16}O(\gamma,p_0)$ ANGULAR DISTRIBUTIONS AT GIANT RESONANCE ENERGIES. Baglin, J. E. E.; Thompson, M. N. (Yale Univ., New Haven). Nucl. Phys., A138: 73-84(1969).

A study was made of the angular distribution of ground state photoprotons from ^{16}O. Proton spectra were recorded simultaneously at 20, 45, 60, 90, 120, 135 and 160° to the incident beam of thin-target bremsstrahlung. The excitation energy range between 20.5 and 30 MeV was covered in 100 keV intervals. The energy dependence and magnitudes of the Legendre coefficients of the angular distribution indicate the contributions of E1 and higher multipole excitations in the giant resonance region. (auth)

6837 SOME PROPERTIES OF THE STATES AT 1.346, 1.459, AND 1.554 MeV IN ^{19}F. Poletti, A. R.; Becker, J. A.; McDonald, R. E. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Phys. Rev., 182: 1054-60(June 20, 1969).

Measurements of the radiative decay of the triplet of levels at 1.346, 1.459, and 1.554 MeV in ^{19}F have been made with a Ge(Li) γ-ray spectrometer. Results of lifetime measurements for these states when averaged with previous work are, respectively, τ_m = 4.9 ± 0.5 psec, 0.084 ± 0.020 psec, and $4.4^{+3.4}_{-2.0}$ fsec. Accurate energies of the three states were determined to be 1345.75 ± 0.20, 1459.1 ± 0.5, and 1554.1 ± 0.3 keV. Information on decay modes and mixing ratios has also been obtained for these states. The decay branching of the 1.459-MeV level was found to differ significantly from that reported by previous investigators. The results are compared with various model predictions. (auth)

6838 CONTINUUM SHELL-MODEL CALCULATION FOR ^{16}O. Perez, J. D.; MacDonald, W. M. (Univ. of Maryland, College Park). Phys. Rev., 182: 1066-73(June 20, 1969). (ORO-3765-15).

The resonance states of ^{16}O have been calculated within a particle-hole basis using the unified-shell-model approach to reaction theory with a finite Saxon–Woods potential and a zero-range effective interaction. Coulomb wave functions are used for both scattering and bound proton orbitals, so the analog spin quantum number is needed. The resonance states for $J^\pi = 0^-$, 1^-, 2^-, and 3^- are presented together with their analog spin impurity and their neutron and proton widths. Coupling to the single-nucleon continuum states produces a downward energy shift and several instances of analog spin mixing. Two $J^\pi = 1^-$ states at 16.23 and 17.26 MeV exhibit a complete breakdown of analog spin and isospin. The $^{16}O(\gamma,p_0)^{15}N$ and $^{16}O(\gamma,n_0)^{15}O$ cross sections are calculated using the K matrix of MacDonald and Mekjian. The effects of isospin impurity in resonance states are drastically suppressed in an illustration of the "dynamic criterion" for isospin mixing in resonant amplitudes. (auth)

6839 PROTON SPIN FLIP IN THE REACTION $^{12}C(p,p')^{12}C^*$ [4.44 MeV]. Kolata, J. J.; Galonsky, A. (Michigan State Univ., East Lansing). Phys. Rev., 182: 1073-82(June 20, 1969).

The angular correlation between protons inelastically scattered from the first excited state of ^{12}C and the subsequent 4.44-MeV deexcitation γ radiation perpendicular to the scattering plane was measured for 26.2- and 40.0-MeV incident proton energy. This correlation has previously been shown to be related to the fraction of protons undergoing spin flip along this direction. As has been observed at lower bombarding energies, the spin-flip probability peaks at large proton scattering angles; observed here are probabilities as high as 0.35 near 150°. The spin-flip probability for all inelastic scattering to the 4.44-MeV state is 3%. The data were compared to the predictions of the distorted-wave Born approximation, using collective-model and microscopic-model form factors. The expected sensitivity to the spin-dependent part of the nucleon-nucleus interaction was confirmed. However, it was found that the observed spin flip was almost entirely accounted for by distortions in the entrance and exit elastic channels, due to the spin-orbit term in the optical-model potential. No definite conclusions regarding the spin-dependent part of the inelastic interaction could be reached from the ^{12}C data, possibly owing to the failure of the assumptions of the optical model for such light nuclei. It appears that meaningful information regarding the spin dependence of the reaction mechanism producing the excited state can be obtained from spin-flip data only for those nuclei having well-determined optical-model parameters. (auth)

6840 $^{16}O(\gamma,n)^{15}O^*$ AND $^{16}O(\gamma,p)^{15}N^*$ REACTIONS AND THE ELECTROMAGNETIC DECAY OF $^{15}O^*$ AND $^{15}N^*$. Murray, Kenneth M.; Ritter, James C. (Naval Research Lab., Washington, D. C.). Phys. Rev., 182: 1097-1103(June 20, 1969).

γ rays resulting from the decay of excited states in ^{15}O and ^{15}N have been observed when these states were produced from (γ,n) and (γ,p) reactions on ^{16}O. Bremsstrahlung from the Naval Research Laboratory's 60-MeV Electron Linac was used as a source of x rays to produce the photonuclear reactions leading to $^{15}N^*$ and $^{15}O^*$. The 5-MeV positive-parity quadruplet resulting from the above-described reactions was resolved into its four separate components and the width of each component was observed. Limits on lifetimes for all of the observed transitions were determined from the Doppler broadening of these lines. The $\frac{5}{2}^+$ states at 5.240 MeV in ^{15}O and at 5.270 MeV in ^{15}N were observed to have lifetimes considerably greater than 10^{-13} sec. All other observed transitions showed lifetimes short compared to 10^{-13} sec. It was also observed that the branching ratio of the 9.223-MeV level in ^{15}N to the $\frac{1}{2}^+$ state at 5.299 MeV could not be greater than ~50%. (auth)

6841 GAMMA RAYS FROM PROTONS ON ^{10}B, AND THE EXCITATION ENERGY OF THE FIRST EXCITED STATE OF ^{10}C. Paddock, R. A.; Austin, S. M.; Benenson, W.; Proctor, I. D.; St. Amant, F. (Michigan State Univ., East Lansing). Phys. Rev., 182: 1104-5(June 20, 1969).

The energy of the first excited state of ^{10}C has been measured using the $^{10}B(p,n\gamma)^{10}C$ reaction. The excitation energy was found to be 3.3527 MeV, with an error assignment of 1.5 keV. Also reported are excitation energies for the first four excited states of ^{10}B. (auth)

6842 ANGULAR CORRELATIONS IN THE $^7Li(p,\gamma)^8Be$ (16.63 MeV) $\rightarrow 2\alpha$ REACTION. Sweeney, W. E. Jr. (Univ. of Maryland, College Park). Contract AT-(40-1)-2098. Phys. Rev., 182: 1022-30(June 20, 1969).

Angular correlations between the γ ray populating the 16.63-MeV state of ^8Be and the subsequent breakup α particles have been measured at the 0.441-MeV resonance of the $^7Li(p,\gamma)^8Be$ reaction and at an incident proton energy of 1.50 MeV. At the latter energy, the reaction is assumed to proceed by a direct-capture process involving both S- and D-wave protons. An expression for the $\gamma-\alpha$ angular correlation for a direct-capture reaction is derived, and it compares favorably with the experimental results. The measurement at the 0.441-MeV resonance shows that the 17.64-16.63-MeV γ-ray transition is nearly pure M1 with a transition amplitude ratio $\delta = \langle E2\rangle/\langle M1\rangle = -0.014 \pm 0.013$. (auth)

6843 GAMMA-RAY TRANSITIONS INVOLVING ISOBARIC-SPIN MIXED STATES IN ^8Be. Sweeney, W. E. Jr.; Marion, J. B. (Univ. of Maryland, College Park). Contract AT-(40-1)-2098. Phys. Rev., 182: 1007-21(June 20, 1969).

The cross sections for the reactions $^7Li(p,\gamma)^8Be^*$ (16.63 and 16.90 MeV) $\rightarrow 2\alpha$ were measured over the range of bombarding energies 0.441 to 2.45 MeV. The nonresonant portion of the cross section for the population of the 16.63-MeV level has been compared successfully with cross sections calculated on the assumption of an extranuclear direct-capture process. Resonant cross sections populating the 16.63- and 16.90-MeV levels of ^8Be were measured at incident energies of 0.441, 1.03, and 1.89 MeV, corresponding to levels at 17.64, 18.15, and 18.9 MeV in ^9Be. Partial widths and reduced matrix elements were calculated for the resonant contributions to the cross sections. The experimental results are consistent with the hypothesis of nearly maximal isobaric-spin mixing in the $J^\pi = 2^+$ levels of ^8Be (16.63 and 16.90 MeV). There is no evidence for transitions from the $J^\pi = 3^+$ levels near 19 MeV to either of the 16-MeV states, but decay to these states was observed from a level (probably $J^\pi = 2^-$) at 18.9 MeV. (auth)

6844 OPTICAL-MODEL ANALYSIS OF NUCLEON SCATTERING FROM 1p-SHELL NUCLEI BETWEEN 10 AND 50 MeV. Watson, B. A. (Argonne National Lab., Ill. Indiana Univ., Bloomington); Singh, P. P.; Segel, R. E. Phys. Rev., 182: 977-89(June 20, 1969).

Differential cross sections for protons scattered from ^{10}B were measured and, combined with published differential cross sections and polarizations for protons elastically scattered from ^6Li, ^7Li, ^9Be, ^{10}B, ^{11}B, ^{12}C, ^{13}C, ^{14}N, and ^{16}O at bombarding energies between 10 and 50 MeV, are analyzed in terms of the optical model. An investigation of the systematic effects observed in applying the optical model to light nuclei reveals two peculiarities. First, an examination of the effects of a nonlocal potential indicates that the radius parameter of the real central potential is energy-dependent. Second, the Thomas form usually used for the spin-orbit potential is shown to lose its surface-peaked character in the case of light nuclei; but a proposed slight modification avoids this defect. The set of parameters found to give a good description of the data over a range of incident nucleon energy and target mass was shown to be similar to the sets of parameters found to describe the nucleon scattering from heavy nuclei. Using the prescriptions for the parameters of the present study but reversing the signs of the $(N-Z)/A$ terms leads to fits of comparable quality to the differential cross sections for 14-MeV neutrons scattered from ^7Li, ^9Be, ^{11}B, and ^{14}N. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 5648, 5905, 6576, 6823, 6826, and 6827.

6845 (CONF-690818-7) GAMMA-RAY ENERGY MEASUREMENTS OF TRANSITIONS FROM THE FIRST AND SECOND EXCITED LEVELS OF ^{58}Fe. Dyer, N. C.; Rester, A. C.; Croft, W.; Hamilton, J. H. (Vanderbilt Univ., Nashville, Tenn. Dept. of Physics). [1969]. 6p. Dep. CFSTI.

From International Conference on Radioactivity in Nuclear Spectroscopy, Nashville, Tenn.

The gamma-ray energy spectra for the $^{58}Co \rightarrow {}^{58}Fe$ decay were measured with a Ge(Li) detector. The transition energies in ^{58}Fe are compared with previous data from ^{58}Mn decay and $^{57}Fe(n,\gamma)$ reactions. (J.W.R.)

6846 (ORNL-TM-2729) SPECTROSCOPY OF f-p SHELL NUCLEI BY (d,n) REACTIONS. Couch, Richard Gerald (Oak Ridge National Lab., Tenn.). Nov. 1969. Contract W-7405-eng-26. 105p. Dep. CFSTI.

Thesis. Submitted to Northwestern Univ., Evanston, Ill.

In order to obtain information on the proton levels in the 1f-2p shell, (d,n) reactions on $^{54,56}Fe$, ^{59}Co, and $^{64,66,68}Zn$ at 10 MeV were studied. Neutron time-of-flight spectra and angular distributions were taken with liquid scintillators. The data were analyzed with the DWBA. (J.W.R.)

6847 (ORNL-4450) TABULATED CROSS SECTIONS FOR HYDROGEN AND HELIUM PARTICLES PRODUCED BY 62-MeV PROTONS ON ^{89}Y. Bertrand, F. E.; Peelle, R. W. (Oak Ridge National Lab., Tenn.). Oct. 1969. Contract W-7405-eng-26. 35p. Dep. CFSTI.

Tabulated differential cross sections are presented for the production spectra of protons, deuterons, tritons, helium-3, and alpha particles from ^{89}Y bombardment by 61.5-MeV protons. Five detector angles were employed in the range 30 to 124°. The continuum cross sections are given from the maximum energy down to a cutoff (2 to 7 MeV) which depends on particle type. Some improvements in the analysis procedure are discussed. (auth)

6848 (ORO-3346-54) NUCLEAR SPECTROSCOPY AND FAST NEUTRON REACTIONS. Fifth Annual Progress Report. Fink, R. W. (Georgia Inst. of Tech., Atlanta. School of Chemistry). Oct. 31, 1969. Contract AT(40-1)-3346. 15p. Dep. CFSTI.

Research completed or in progress on fast neutron reactions and nuclear spectroscopy with radioactive sources at the Georgia Inst. of Tech. School of Chemistry as of Oct. 31, 1969 is summarized. (J.W.R.)

6849 (TID-25246) SPECTROSCOPY OF f-p SHELL NUCLEI BY (d,n) REACTIONS. Couch, Richard Gerald (Northwestern Univ., Evanston, Ill.). June 1970. 105p. Dep. CFSTI.

Thesis.

The proton levels of 1f-2p shell nuclei were studied using the (d,n) reaction. A 10-MeV pulsed deuteron beam was used for (d,n) reactions on $^{54,56}Fe$, ^{59}Co, and $^{64,66,68}Zn$. Neutron spectra and angular distributions were measured using scintillation detectors. Energy levels and level properties were determined for $^{55,57}Co$, ^{60}Ni, and $^{65,67,69}Ga$. These levels were compared with previous data from (^3He,d) reactions. (J.W.R.)

6850 LIFETIME OF THE FIRST $\frac{7}{2}^-$ STATE IN ^{33}S. Brandolini, F.; Signorini, C. (Univ., Padua). Phys. Lett., 30B: 342-3(Oct. 27, 1969).

The mean life of the first $\frac{7}{2}^-$ state in ^{33}S was deduced as $\tau_m = 38 \pm 11$ ps from the γ-ray Doppler shift observed with a krypton gas stopper. The structure of this state is discussed in the framework of the shell model. (auth)

6851 SYSTEMATICS OF $l = 5$ (d,p) TRANSITIONS IN NUCLEI WITH $89 \leq A \leq 101$. Booth, W. (Univ. of Bradford, Eng.);

Dalgliesh, S. M.; McLean, K. C.; Glover, R. N.; Hudson, F. R. Phys. Lett., 30B: 335-6(Oct. 27, 1969).

Strong l = 5 transitions have been discovered in (d,p) reactions on Sr, Zr and Mo isotopes. These low lying $1^1/_2^-$ states are described by coupling the collective 3^- core state to the odd neutron. The "$g_{9/2}$–$h_{9/2}$ anomaly" can be explained by fragmentation of the $h_{9/2}$ single-particle strength, not all the components of which have been observed experimentally. (auth)

6852 ISOSPIN SPLITTING OF E1 RESONANCES IN ^{88}Sr AND ^{90}Zr. Hasinoff, M.; Fisher, G. A.; Kuan, H. M.; Hanna, S. S. (Stanford Univ., Calif.). Phys. Lett., 30B: 337-9(Oct. 27, 1969).

The high-lying $T_>$, E1 resonances are investigated in ^{88}Sr and ^{90}Zr by means of the reactions ^{87}Rb(p,γ_0)^{88}Sr, ^{87}Rb(p,p_0)^{87}Rb, ^{89}Y(p,γ_0)^{90}Zr and ^{89}Y(p,p_0)^{89}Y. (auth)

6853 NMR IN AN ISOMERIC STATE FOLLOWING A NUCLEAR REACTION. Quitmann, D.; Jaklevic, J. M.; Shirley, D. A. (Univ. of California, Berkeley). Phys. Lett., 30B: 329-31(Oct. 27, 1969).

The isomeric state in ^{73}As (426 keV, $^9/_2^+$, $\tau_{\frac{1}{2}} = 6\ \mu s$) was produced and aligned by the ^{71}Ga(α,2n) reaction in a liquid Ga metal target. The resulting γ-ray anisotropy was attenuated by inducing NMR transitions with a 1 MHz rf field. The value g = +1.146 ± 0.007 was determined. (auth)

6854 T = $^3/_2$ STATES IN ^{21}Na AS SEEN IN THE ^{20}Ne(p,p)^{20}Ne REACTION. McDonald, A. B.; Patterson, J. R.; Winkler, H. (California Inst. of Tech., Pasadena). Nucl. Phys., A137: 545-60(1969).

The two lowest T = $^3/_2$ states in ^{21}Na were observed as narrow scattering anomalies in ^{20}Ne(p,p)^{20}Ne, using a differentially pumped gas target. The observed resonance energies are E_p = 6.872 ± 0.005 MeV and E_p = 7.128 ± 0.005 MeV corresponding to E_x = 8.973 ± 0.007 MeV and E_x = 9.217 ± 0.007 MeV in ^{21}Na. No other narrow scattering anomaly was found in the proton laboratory energy range 6.76 to 7.33 MeV although six anomalies of width greater than 13 keV were seen. From an analysis of the data using single level dispersion theory the following parameters were extracted for the T = $^3/_2$ states: for the 8.973-MeV state, $J^\pi = {}^5/_2^+$ (or $^3/_2^+$), $\Gamma_{total} < 1.2$ keV, $\Gamma_{p_0} = 0.10 \pm 0.05$ keV and, for the 9.217-MeV state, $J^\pi = {}^1/_2^+$, $\Gamma_{total} = 2.3 \pm 0.5$ keV and $\Gamma_{p_0} = 1.1 \pm 0.3$ keV. (auth)

6855 NUCLEAR PHOTOACTIVATION OF ^{77}Se, ^{107,109}Ar, ^{111}Cd, ^{115}In, AND ^{199}Hg. Boivin, M.; Cauchois, Y.; Heno, Y. (Faculte des Sciences, Paris). Nucl. Phys., A137: 520-30(1969). (In French).

The photoactivation of various isotopes is studied using the x-ray bremsstrahlung produced by a 2-MeV electron accelerator. The photoactivation cross section was calculated for each of the observed nuclear levels. Some of these levels were observed for the first time. Their probable characteristics are proposed or confirmed. In certain cases it was possible to determine partial widths and the mean life of the level. (auth)

6856 DELAYED HEAVY-PARTICLE EMISSION FROM ^{24}Al AND ^{32}Cl. Steigerwalt, J. E.; Sunier, J. W.; Richardson, J. Reginald (Univ. of California, Los Angeles). Nucl. Phys., A137: 585-92(1969).

The energy spectra of the delayed heavy particles emitted from levels in ^{24}Mg and ^{32}S following the beta decay of ^{24}Al and ^{32}Cl, respectively, are presented. Alpha transitions were found from the 11.23-MeV, 11.70-MeV and 12.13-MeV levels of ^{24}Mg and from the 8.79-MeV and 9.47-MeV levels of ^{32}S. Proton transitions were measured from the 9.65-MeV, 9.91-MeV and 10.26-MeV levels of ^{32}S. The relative intensities of the positron decays to the heavy particle emitting levels of ^{32}S were measured as well as the absolute positron branching ratio to the alpha particle unstable levels of ^{24}Mg. The energy levels deduced in ^{24}Mg and ^{32}S are compared with known energy levels and their spin and parity assignments are discussed. (auth)

6857 ^{34}Ar AND T = 1 STATES IN ^{34}Cl FROM TWO-NUCLEON PICK-UP REACTIONS. Brunnader, H.; Hardy, J. C.; Cerny, Joseph (Univ. of California, Berkeley). Nucl. Phys., A137: 487-99(1969).

The reactions ^{36}Ar(p,t)^{34}Ar, ^{36}Ar(p,^{3}He)^{34}Cl and ^{36}Ar(d,α)^{34}Cl were used to study energy levels in ^{34}Ar and ^{34}Cl. Excitation energies and J^π values were established for states up to 8 MeV in ^{34}Ar, and many of their T = 1 analogs were identified in ^{34}Cl. These results exemplify the usefulness of the spin and isospin selection rules inherent in two-nucleon transfer reactions. The results are discussed in terms of the mass-34 T = 1 multiplet and the J-dependence of their Coulomb displacement energies. (auth)

6858 LIFETIMES AND MAGNETIC MOMENTS OF LEVELS IN ^{57}Fe. Sprouse, G. D.; Hanna, S. S. (Stanford Univ., Calif.). Nucl. Phys., A137: 658-78(1969).

The B(E2) values of the 136-, 367- and 707-keV levels of ^{57}Fe and the 847-keV level of ^{56}Fe are measured. From angular distribution measurements of the decay gamma rays, the E2/M1 mixing ratios are determined. Together with previously determined branching ratios, these data are used to obtain lifetimes of the levels, which are compared with directly measured lifetimes. The Doppler-shift method is used to determine the lifetimes of the 367- and 707-keV levels of ^{57}Fe and the 847-keV level of ^{56}Fe. The magnetic moment of the 136-keV level of ^{57}Fe is determined by an integral-precession measurement in an external field. An attempt is made to observe the magnetic moment of the 367-keV state following implantation in an iron environment. All the properties of the levels in ^{57}Fe are compared with recent theories. (auth)

6859 DECAY OF 19 min ^{67}Ge TO LEVELS OF ^{67}Ga. Zoller, W. H.; Gordon, G. E.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Nucl. Phys., A137: 606-28(1969).

The decay of 19 min ^{67}Ge to levels of ^{67}Ga was studied with large Ge(Li) detectors and Ge(Li)–Ge(Li) coincidence experiments. A total of 56 γ-rays were observed and all but 8 were placed in the decay scheme. Levels are observed in ^{67}Ga at 167, 359, 828, 911, 1082, (1203), (1556), 1640, 1810, 1976, 2527, 2620, 2731, 3162, 3225, 3402, 3632, 3655 and 3728 keV. The levels below 3600 keV were also seen in one or more nuclear-reaction studies. We found no evidence for a level at 33 keV that was previously proposed to decay via a cascade of unresolved 166.5 keV γ-rays. Levels observed in odd-mass isotopes of Cu, Ga and As are discussed and compared with theoretical predictions. (auth)

6860 PROMPT GAMMA-RAY SPECTRA FROM 2-keV NEUTRON CAPTURE IN MANGANESE AND TANTALUM. Greenwood, R. C.; Harlan, R. A.; Reich, C. W. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 12: 927-8(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6861 GAMMA-RAY SPECTRA ARISING FROM THERMAL-NEUTRON CAPTURE IN TITANIUM, NICKEL, ZINC, CHLORINE, SULFUR, AND A STAINLESS STEEL. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 929-30(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6862 NEUTRON CROSS SECTIONS FROM PULSED-BEAM VAN DE GRAAFF. Perey, F. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 923(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6863 EVALUATION OF THE TOTAL CROSS SECTION OF IRON. Irving, D. C.; Straker, E. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 924-5(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6864 LOW-ENERGY GAMMA-RAY YIELDS IN ^{23}Na AND ^{57}Fe. Yost, K. J. (Oak Ridge National Lab., Tenn.); Pitkanen, P. H.; Fu, C. Y. Trans. Amer. Nucl. Soc., 12: 925-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6865 INELASTIC SCATTERING CROSS-SECTION MEASUREMENTS FOR IRON, NIOBIUM, AND TANTALUM. Rogers, V. C.; Clikeman, F. M.; Beghian, L. E. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 746-7 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6866 NUMBER OF SPURIOUS STATES IN n-DIMENSIONAL HARMONIC OSCILLATOR SYSTEMS. Buettner, H. (Battelle-Institut e. V., Frankfurt am Main); Suessmann, G. Nucl. Phys., A137: 167-76(1969).

The fraction of the spurious states was estimated using the harmonic shell model: (a) for low energies by combinatorial, and (b) for high energies by thermodynamic methods. The levels of ^{40}Ca, classified by J, were treated as a special example. (auth)

6867 A 385-MeV MEASUREMENT OF (p,2p) CROSS SECTIONS IN MEDIUM-WEIGHT AND HEAVY NUCLEI. James, A. N.; Andrews, P. T.; Kirkby, P.; Lowe, B. G. (Univ. of Liverpool). Nucl. Phys.; A138: 145-62(1969).

Measurements of differential cross sections for (p,2p) reaction

at an incident proton energy of 385 MeV are interpreted in terms of a distorted momentum distribution for the struck proton in the original target nucleus. The target nuclei studied were ^{40}Ca, ^{45}Sc, ^{59}Co, ^{58}Ni, ^{120}Sn, ^{208}Pb and ^{209}Bi. In all but the heaviest nuclei, the distorted momentum distribution varies with binding energy of the proton in such a way as to invite a simple shell-model interpretation. This simple interpretation indicates that the binding energy of the 1s protons does not increase with mass number after it has reached a value near 55 MeV. (auth)

6868 LEVELS OF ^{82}Kr FROM THE DECAY OF 35 h ^{82}Br. Liukkonen, E.; Hattula, J.; Anttila, A. (Univ. of Helsinki). Nucl. Phys.: A138: 163-70(1969).

The decay of the 35 h ^{82}Br was studied with Ge(Li) detectors and with Ge(Li)–NaI(Tl) coincidence and anti-Compton spectrometers. Gamma-ray energies and relative intensities were determined. Five new γ-transitions are reported and placed in the decay scheme, which contains levels at 776.3, 1474.4, 1820.1, 1956.8, 2093.6, 2426.6, (2546.8), 2555.8, 2647.8 and 2827.9 keV. A spin value of 5 is deduced for the 2827.9 keV level from the measured directional correlation function of the 1008 to 1044 keV γ-ray cascade and from the log ft value of the β-transition populating this level. (auth)

6869 STRUCTURE IN THE ^{27}Al(p,α)^{24}Mg CROSS SECTION BETWEEN E_p = 4.0 AND 5.5 MeV. Mehta, M. K.; Divatia, A. S. (Bhabha Atomic Research Centre, Bombay). Nucl. Phys.; A138: 171-6(1969).

The excitation functions of the reactions ^{27}Al(p,α_0)^{24}Mg and ^{27}Al(p,α_1)^{24}Mg* were measured in the proton energy range E_p = 4.0 to 5.5 MeV with an energy resolution of about 5 keV at lab angles of 60, 90, and 165°. The excitation curves exhibit sharp maxima of widths between 10 and 50 keV superimposed on a broad 150 to 300 keV wide structure. The channel as well as angle cross correlation functions calculated with moving averages are high for all the cases. This as well as strong visual correlations of the sharp and the broad structure between various curves lead to the conclusion that the observed structure, both fine as well as broad, is due to individual resonance effects and not to fluctuations. It is suggested that the fine structure is due to very slightly overlapping compound nuclear levels, while the broad structure may represent the "intermediate states" of the compound system. (auth)

6870 REACTION MECHANISMS IN ^{75}As + n SYSTEM. Prasad, P. Rama; Rama Rao, J.; Kondaiah, E. (Andhra Univ., Waltair, India). Nucl. Phys.; A138: 85-9(1969).

Cross sections for the (n,2n), (n,α) and (n,p) reactions on ^{75}As at an incident neutron energy of 14.2 ± 0.2 MeV were measured using the activation technique and a low background gamma counting set-up consisting of a well-type NaI(Tl) scintillation spectrometer. The values obtained are: ^{75}As(n,2n)^{74}As: 1170 ± 117 mb; ^{75}As(n,α)^{72}Ga: 13.6 ± 1.6 mb; ^{75}As(n,p)^{75m}Ge: 8 ± 1 mb; ^{75}As(n,p)^{75g}Ge: 16 ± 2.4 mb. The experimental cross sections for the (n,2n) and (n,α) reactions show good agreement with the theoretical values calculated on the basis of the statistical model with a level density parameter, a = $\frac{1}{8}$A. In the case of ^{75}As(n,p)^{75m,g}Ge, however, the measured total cross section and isomeric ratio deviate considerably from the statistical predictions indicating direct interaction contribution to the (n,p) reaction. (auth)

6871 LEVELS OF ^{75}Se FROM THE DECAY OF ^{75}Br. Ray, S.; Mo, J. N.; Muszynski, S.; Mark, S. K. (McGill Univ., Montreal). Nucl. Phys.; A138: 49-60(1969).

The β^+ decay of ^{75}Br to levels of ^{75}Se was investigated with the use of Ge(Li), NaI(Tl) gamma-ray detectors and Si(Li) positron detector. Seven gamma rays and five positron branches were observed. On the basis of various gamma-gamma, gamma-beta coincidences and positron intensity measurements, a decay scheme is proposed with levels of ^{75}Se located at 111.8, 286.5, 427.5, 579.5, 663.8 and 859.1 keV. The half-life of the 286.5-keV level was measured to be $\tau_{\frac{1}{2}}$ = 1.23 ± 0.15 ns. The properties of the levels are discussed. (auth)

6872 A NEW MEASUREMENT OF THE ft VALUE FOR THE MIRROR DECAY ^{35}Ar(β^+)^{35}Cl AND A CALCULATION OF THE VECTOR COUPLING CONSTANT. Wick, G. L.; Robinson, D. C.; Freeman, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys.; A138: 209-30(1969).

Accurate measurements were made of the threshold for the reaction ^{35}Cl(p,n)^{35}Ar, and of the branching ratios and half-life in the decay ^{35}Ar(β^+)^{35}Cl. The threshold, 6941.2 ± 1.7 keV leads to the value 4941.6 ± 1.7 keV for the beta end-point in the ground state decay of ^{35}Ar, and the corresponding f-value is 3112.3 ± 5.0. The result obtained for the branching ratio for the ground state decay was 98.54 ± 0.05%. The half-life measurements gave the result $t_{\frac{1}{2}}$ = 1.770 ± 0.006 sec. After application of a radiative correction of +1.45%, the ft value for the mirror transition was thus determined to be 5671 ± 21 sec, excluding uncertainties in the radiative correction. This value is much more accurate and significantly lower than previous measurements. When combined with the result of Calaprice et al. for the spatial asymmetry of positons from the decay of nuclear spin polarized ^{35}Ar, the present ft value leads to a value for the weak interaction vector coupling constant in beta decay of G_V^V = (1.460 ± 0.006) × 10^{-49} erg · cm^3. This value is seriously out of line with results obtained from J = 0^+, T = 1 decays, and from other mirror decays. Further experimental work, particularly on the branching ratios and the asymmetry measurement are indicated, as well as considerations of possible nuclear structure or other effects. (auth)

6873 PRECISION DETERMINATION OF THE K-SHELL FLUORESCENCE YIELD OF GALLIUM. Freund, H. U.; Genz, H.; Siberts, J. B.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Nucl. Phys.; A138: 200-8(1969).

A large, wall-less multiwire proportional counter containing a gaseous source of $^{71}GeH_4$ has been used in a precision determination of the K-shell fluorescence yield of gallium. Runs were performed with various pressures (0.3 to 6 atm) of pure propane and of argon-propane mixtures. Extensive evaluation was made of the detector efficiencies for K-Auger electrons and K x-rays following K-capture events in ^{71}Ge. The value found is ω_K = 0.528 ± 0.006. Critical comparison with previous measurements of ω_K for gallium shows that methods involving solid sources of ^{71}Ge are subject to large systematic errors. (auth)

6874 TRITON ELASTIC SCATTERING AT 20 MeV. Flynn, E. R.; Armstrong, D. D.; Beery, J. G.; Blair, A. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 182: 1113-20(June 20, 1969).

An optical-model analysis of the elastic scattering of 20-MeV tritons from 17 nuclides, from ^{40}Ca to ^{208}Pb, is presented. Average-parameter geometry sets as well as best-fit parameters are given. Two basic parameter families are considered, these being based on real-well radius parameters of 1.25 and 1.16 F, respectively. Average-geometry fits to all of the data indicate that the real-well depth is almost constant for all nuclides, whereas the imaginary depth shows a strong dependence on (N–Z)/A. (auth)

6875 STUDY OF THE ^{45}Sc(α,t)^{46}Ti REACTION AT 41 MeV. Priest, Joseph R.; Vincent, John S. (Lewis Research Center, Cleveland). Phys. Rev., 182: 1121-30(June 20, 1969).

Thirteen angular distributions have been measured from 8° to 70° for the ^{45}Sc(α,t)^{46}Ti reaction at 41 MeV. Very selective population of the states of ^{46}Ti was observed, and the populated states correlate well with states of the ^{45}Sc(^{3}He,d)^{46}Ti reaction which have large l_p = 3 spectroscopic strengths. The angular distributions have little structure and exhibit the same basic shape. The distorted-wave Born-approximation (DWBA) noncutoff calculations for the stripping of an l_p = 3 proton provides an adequate description of the angular distributions. The relative spectroscopic strengths extracted from the DWBA analysis agree favorably with those deduced from a similar study of the ^{45}Sc(^{3}He,d)^{46}Ti reaction. Theoretical spectroscopic strengths calculated from the McCullen–Bayman–Zamick single-particle wave functions for the ground state of ^{45}Sc and five low-lying states of ^{46}Ti are in reasonable agreement with experiment. (auth)

6876 ISOBARIC ANALOG STATES OF ^{51}Ti STUDIED BY ELASTIC AND INELASTIC SCATTERING OF PROTONS ON ^{50}Ti. Cosman, E. R.; Slater, D. C.; Spencer, J. E. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 182: 1131-41(June 20, 1969).

The isobaric analogs of levels in ^{51}Ti from E_x = 2.0–5.5 MeV are observed as resonances in (p,p′) scattering on ^{50}Ti. Excitation functions for the inelastic p_1' (2^+) and p_2' (4^+) transitions have been determined at θ_{lab} = 90° and 160° from an incident energy of 3.4 to 7.1 MeV. Twenty-two analog resonances have been identified within this range, and aspects of the accompanying intermediate and fine structure are discussed. Several on-resonance angular distributions have been measured. In some cases, they display marked asymmetries about 90°, indicating the presence of direct-reaction interference effects. A Breit–Wigner analysis of the elastic and inelastic data was carried out, and the resulting partial and total widths are given. The associated spectroscopic factors and excitation energies are compared with the values found from ^{50}Ti(d,p)^{51}Ti. Several possible reaction processes are considered in the description of the resonant inelastic proton transitions to the first 0^+, 3^+, and 4^+ states in ^{50}Ti, and information on the levels of ^{51}Ti is discussed in terms of the core-excited model. (auth)

6877 EXCITATION OF THE $\frac{1}{2}^+$, 2.02-MeV STATE IN ^{41}Ca BY THE (t,d) REACTION. Satchler, G. R. (Oak Ridge National

Lab., Tenn.); Armstrong, D. D.; Blair, A. G.; Flynn, E. R.; Philpott, R. J.; Pinkston, W. T. Phys. Rev., 182: 1141-8(June 20, 1969).

The ^{40}Ca(t,d) reaction, with 20-MeV tritons, was used to excite the ground and first two excited states of ^{41}Ca. The measured differential cross sections were analyzed using the distorted-wave method, assuming the usual first-order stripping mechanism. The triton optical potential was obtained by fitting measurements of the elastic scattering. The spectroscopic factor C^2S for $d_{\frac{3}{2}}$ capture into the 2.02-MeV state was found to be about 0.06 times that for $f_{\frac{7}{2}}$ capture into the ground state when the usual well-depth prescription was used for the neutron wave function. More realistic $d_{\frac{3}{2}}$ neutron form factors based upon simple model wave functions for ^{40}Ca and ^{41}Ca were also used. They led to spectroscopic factors which are at least twice as large and are found to be very sensitive to the type of nucleon–nucleon interaction assumed. The implications for the amount of particle-hole excitation in the ground state of ^{40}Ca are discussed. (auth)

6878 LEVEL DENSITIES FROM EXCITATION FUNCTIONS OF ISOLATED LEVELS. Huizenga, J. R. (Univ. of Rochester, N. Y. Argonne National Lab., Ill.); Vonach, H. K.; Katsanos, A. A.; Gorski, A. J.; Stephan, C. J. Phys. Rev., 182: 1149-64 (June 20, 1969).

Thick-target excitation functions were measured for the reactions ^{53}Co(p,α_0)^{50}Fe, ^{53}Co(p,α_1)^{50}Fe, ^{56}Co(p,α_2)^{53}Fe, ^{55}Mn(p,α_0)^{52}Cr, ^{55}Mn(p,α_1)^{52}Cr, and ^{62}Ni(p,α_0)^{59}Co at two or more angles for proton bombarding energies 6 to 13.5 MeV. The ^{56}Fe(α,p$_0$)^{59}Co reaction was studied at α-particle bombarding energies of 12 to 18.5 MeV. These measurements were used to determine the parameters in three different level-density formulas which were thought to be reasonable candidates to describe the level densities of the residual nuclei. In addition, the experimental values of the cross sections to isolated levels were used in conjunction with available values of the level width Γ from cross-section fluctuation measurements to determine level densities of compound nuclei at about 20-MeV excitation energy. The absolute values and energy dependence of the nuclear level density in the excitation energy range 0 to 20 MeV investigated for several nuclei agree with a back-shifted Fermi gas model. The constant-temperature model gives a reasonable fit to the level density in the energy range 0 to 10 MeV but fails at higher excitation energies. The conventional shifted Fermi gas model does not reproduce the energy dependence and absolute values of the various experimental level densities for any value of the level-density parameter a. (auth)

6879 LIFETIMES OF EXCITED STATES OF ^{51}V, ^{61}Ni, ^{69}Ga, ^{75}As, ^{79}Br, ^{85}Rb, AND ^{123}Sb; Shipley, E. N.; Holland, R. E.; Lynch, F. J. (Argonne National Lab., Ill.). Phys. Rev., 182: 1165-8(June 20, 1969).

The lifetimes of states at low excitation in several odd-A nuclei have been measured by a pulsed-beam technique. The results (in nsec) of the measurements for the levels at the excitation energies (in keV) listed in parentheses are ^{51}V(320), 0.28 ± 0.05; ^{61}Ni(67), 7.3 ± 0.3; ^{69}Ga(320), <0.1; ^{75}As(199), 1.30 ± 0.25; ^{75}As(280), 0.43 ± 0.08; ^{79}Br(217), <0.2; ^{85}Rb(150), 1.01 ± 0.10; ^{123}Sb(160), 0.82 ± 0.10. (auth)

6880 LEVELS IN ^{35}Cl POPULATED BY ^{34}S(d,n)^{35}Cl. Davison, N. E. (Univ. of Alberta, Edmonton); Sample, J. T.; McDonald, W. J.; Wiesehahn, W. J.; Azuma, R. E.; Prentice, J. D. Phys. Rev., 182: 1168-73(June 20, 1969).

The low-lying levels in ^{35}Cl were populated by the reaction ^{34}S(d,n)^{35}Cl at 4.95 MeV. The neutron spectrum was measured using the time-of-flight technique. Interpretation of the angular distribution of the neutrons, together with results of previous experiments, confirmed or determined the following spin–parity assignments: $J^\pi = \frac{3}{2}^+, \frac{1}{2}^+, \frac{5}{2}^+, \frac{5}{2}^-$, and $\frac{7}{2}^-$ for the levels at 0.0, 1.220, 1.762, 3.006, and 3.163 MeV, respectively. (auth)

6881 ^{58}Mn ISOMERS. Ward, T. E.; Pile, P. H.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Contract AT-(40-1)-3235. Phys. Rev., 182: 1186-9(June 20, 1969).

A new 3.0 ± 0.1-sec activity with a 6.1 ± 0.3-MeV β endpoint energy was assigned to an isomer of ^{58}Mn. The decay of the 65-sec ^{58}Mn isomer was studied and a β-decay Q value of 6.1 ± 0.2 MeV determined. (auth)

6882 INTERPRETATION OF THE PHOTODISINTEGRATION OF ^{58}Ni AND ^{60}Ni IN THE GIANT-RESONANCE REGION. Min, K. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 182: 1359-60(June 20, 1969).

It is pointed out that the anomalous features observed in the photodisintegration of ^{58}Ni and ^{60}Ni in the giant-resonance region can be explained in terms of the isobaric-spin splitting of the dipole excitation. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 5613, 6664, 6823, 6827, 6848, 6851, 6852, 6855, 6865, 6867, 6874, 6879, and 6950.

6883 (JINR-P6-4597) ^{137m}Nd: A NEW ISOMERIC STATE IN N = 77 ISOTONES. Levitovich, E.; Noibert, V.; Khoinatskii, S.; Droste, Kh., Morek, T.; Vil'gel'mi, Z.; Aleksander, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 17p. (In Russian). Dep. CFSTI (U. S. Sales Only).

In the reactions ^{118}Sn(^{22}Ne,4n)^{137}Nd, ^{122}Sn(^{20}Ne,5n)^{137}Nd, ^{122}Sn(^{22}Ne, 7n)^{137}Nd and ^{126}Te(^{16}O,7n)^{137}Nd a new isomeric state with a half-life of 1.60 ± 0.15 sec was found. The atomic number was assigned by means of the conversion electron spectrum from the measured difference of K and L electron binding energies. The mass number follows from excitation function measurements. In the decay of the new isomer the following γ-rays were observed: 108 ± 1 keV, 177 ± 1 keV, 232 ± 0.8 keV (E3-isomeric transition) and 285 ± 1 keV. The systematics of excited states in nuclei with neutron number N = 77 is discussed. (auth)

6884 (JINR-P7-4556) MEASUREMENT OF A NUMBER OF NEUTRONS IN THE FISSION OF NUCLEI BY HEAVY IONS. Karamyan, S. A.; Oganesyan, Yu. Ts.; Sharifov, K. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The experiments on the measurement of the average number of neutrons per fission of excited compound-nuclei, which are produced in the reaction with heavy ions, are described. Glass-detectors were used as the detectors of fast neutrons which make contact with the layer of fissioning matter (^{237}Np). The experimental results agree with the estimates of number ν_f obtained in the experiments on measurement of mass and charge distributions of the fission fragments. (auth)

6885 (LA-3529) COMPARISON OF CALCULATIONS WITH INTEGRAL EXPERIMENTS FOR PLUTONIUM AND URANIUM CRITICAL ASSEMBLIES. Cremer, C. C.; Hunter, R. E.; Berlijn, J.-J. H.; Worlton, D. R. (Los Alamos Scientific Lab., N. Mex.). Aug. 1968. Contract W-7405-eng-36. 22p. Dep. CFSTI.

Results of comparisons of calculated and experimental values of integral experiments involving neutron cross sections of ^{235}U, ^{238}U, ^{239}Pu, and ^{240}Pu are presented. These comparisons were made in an effort to obtain microscopic neutron cross sections that would yield correct results when used in neutronics calculations of fast critical assemblies. (auth)

6886 (LA-4257) SHORT-LIVED DELAYED GAMMA-RAY EMISSION FROM FAST FISSION OF PLUTONIUM. Moore, Billy M. (Los Alamos Scientific Lab., N. Mex.). Sept. 1969. Contract W-7405-eng-36. 79p. Dep. CFSTI.

The short-lived delayed gamma spectra from fast neutron fission of plutonium was experimentally measured by using a Ge(Li) detector. The half-lives and energies of the more prominent gamma rays in the spectra were determined for half-lives in the range 1 min ≤ $t_{\frac{1}{2}}$ ≤ 60 min and for energies in the range 170 keV ≤ E ≤ 1800 keV. From the delayed gamma spectra, yields were determined for the short-lived fission products ^{89}Rb, ^{90}Rb, ^{94}Sr, ^{94}Y, ^{101}Mo, ^{101}Tc, ^{131}Sb, ^{135m}Xe, ^{136}I, ^{137}Xe, ^{138}Xe, and ^{138}Cs. Minimum estimates of the yields were determined for ^{95}Y, ^{104}Tc, ^{139}Xe, ^{140}Cs, and ^{145}Ce. Also, the delayed gamma spectra from fast fission of ^{239}Pu was compared to that obtained from fast fission of ^{235}U. From the results obtained, conclusions could be reached on what fission products would produce the largest differences in the two spectra at high energy. This particular information is needed to help keep fuel inventory in reactors. This will protect against the unwarranted use of nuclear fuels that are produced in reactors (safeguards). (auth)

6887 (MLM-1692(tr)) SOME NEW RESULTS ON THE DISINTEGRATION OF ^{231}Pa TO ^{227}Ac. Abou-Lelia, H.; Foucher, R.; De Pinho, A. G.; Perrin, N. Translated by A. G. Barnett (Mound Lab., Miamisburg, Ohio), from J. Phys. (Paris), 24: 857-8(1963). 8p. Dep. CFSTI.

The ^{231}Pa → ^{227}Ac disintegration was investigated by conversion electron spectrography and gamma spectrometry. Internal conversion coefficients, intensities, and a new upper limit of the half-life are given for the most important transitions de-exciting the K = ½−(530) rotational band. (auth)

6888 (TID-3317 (Suppl. 1)) TRANSPLUTONIUM ELEMENTS. A BIBLIOGRAPHY. PART I: 95 ≤ Z ≤ 101. PART II: Z ≥ 102. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Sep 1969. 33p. Dep. CFSTI.

This bibliography comprises 209 articles on the transplutonium elements compiled since the issuance of TID-3317 and through the period ending June 30, 1969. Part I includes 153 references dealing with the production and the physical and nuclear properties of the elements $95 \leq Z \leq 101$. Part II includes 56 references covering all aspects of the transmendelevium elements. An innovation in this first supplement is the addition of a subject index. Also, the author index has been modified to include the publication title or a shortened version of the title. (C.E.S.)

6889 MASS-DEPENDENT STRUCTURE IN THE FISSION γ-RAY YIELDS FROM ^{252}Cf. John, W.; Wesolowski, J. J.; Guy, F. (Univ. of California, Livermore). Phys. Lett., 30B: 340-1 (Oct. 27, 1969).

A correlation exists between the mass-dependent structure in the yield of prompt γ-rays from spontaneous fission of ^{252}Cf. The total γ-ray yield versus mass resembles the neutron yield sawtooth. (auth)

6890 LIGHT NUCLEI FROM ^{233}U NEUTRON FISSION. Vorobev, A. A.; Seleverstov, D. M.; Grachov, V. T.; Kondurov, I. A.; Nikitin, A. M.; Egorov, A. I.; Zalite, Yu. K. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 30B: 332-4(Oct. 27, 1969).

The energy spectra and the relative intensities of ^{3}H, ^{5}H, ^{4}He, ^{6}He, ^{8}He, ^{7}Li, ^{8}Li, ^{9}Li, ^{9}Be, and ^{10}Be from ^{233}U neutron fission were measured with a mass spectrometer measuring time-of-flight and energy. The upper limits of the yields of ^{3}He, ^{8}Li, and ^{7}Be were determined; the yields proved to be low as compared to the intensities of the other identified particles. (auth)

6891 AVERAGE CHARACTERISTICS OF PROMPT NEUTRON EMISSION FROM FISSION. Kluge, Gy.; Lajtai, A. (Central Research Inst. for Physics, Budapest). Phys. Lett., 30B: 311-12(Oct. 27, 1969).

The predictions obtained by using more accurate expressions for the average neutron energy in terms of a statistical model described earlier, are compared with the experimental data on the thermal neutron fission of ^{233}U, ^{235}U and ^{239}Pu and on the spontaneous fission of ^{252}Cf. (auth)

6892 EXCITATION AND KINETIC ENERGIES OF PROMPT FISSION FRAGMENTS. Sarkar, R. (Saha Inst. of Nuclear Physics, Calcutta); Chatterjee, A. Phys. Lett., 30B: 313-16 (Oct. 27, 1969).

Excitation and kinetic energies of prompt fragments from the thermal neutron induced fission of ^{235}U and spontaneous fission of ^{252}Cf are estimated by using a renormalized gas model and the potential energy surface concept. The predictions agree fairly well with experiments. (auth)

6893 RESONANCE ABSORPTION OF THE 32.2 keV GAMMA RAY OF ^{201}Hg. Carlson, D. E.; Temperley, A. A. (Army Aberdeen Research and Development Center, Edgewood Arsenal, Md.). Phys. Lett., 30B: 322-3(Oct. 27, 1969).

Resonance absorption of the 32.2 keV γ ray of ^{201}Hg was observed by comparing the γ-ray activity at 300°K and 77°K. Calculations of the resonance absorption cross section favor a spin of $\frac{1}{2}^-$ for the 32.2 keV level. (auth)

6894 INTERNATIONAL COMPARISONS OF ^{241}Am. Konstantinov, A. A.; Alekseev, V. Ya. At. Energ. (USSR), 27: 73-5(July 1969). (In Russian).

A total of 21 national laboratories participated in comparison measurements of the alpha emitter ^{241}Am. All the laboratories used absolute methods of alpha counting, primarily proportional counters having methane, propane or a mixture of argon plus 10% methane as the working gas. The activity was also determined by 4π alpha-gamma coincidence counting with the use of a 4π alpha counter for the registration of alpha actvivity, and a scintillation counter for the registration of the gamma activity. Liquid scintillation counting was also used. Results which were not corrected for absorption were discarded. The most probable value for the specific activity of the ^{241}Am was declared to be 11.29 disintegrations per second-mg ±0.2%. (TTT)

6895 ELECTRON-CAPTURE DECAY OF ^{204}Po. Kusch, W.; Chuburkova, I. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 36: 265-8(Aug. 1969).

Electron-capture decay of ^{204}Po (from ^{197}Au(^{15}N, 4n)^{208}Em → ^{204}Po) was investigated with a Ge detector, and a tentative energy level scheme of ^{204}Bi is discussed. (auth)

6896 INTENSITY RULES IN THE DECAY OF ^{172}Lu. Moroz, Z. (Inst. of Nuclear Physics, Warsaw); Jastrzebski, J.; Preibisz, Z.; Stryczniewicz, K.; Paris, P.; Treherne, J. Acta Phys. Pol., 36: 203-10(Aug. 1969).

The γ rays accompanying the ^{172}Lu → ^{172}Yb decay were measured using a high resolution Ge(Li) detector. Experimental branching ratios for interband transitions are compared with the generalized intensity rules of Bohr–Mottelson and Michailov. Multipolarity mixture for the transitions in the $K^{\pi} = 3^+$, 1173 keV band are studied and the $(g_K - g_R/Q_0)$ value estimated. (auth)

6897 MAGNETIC MOMENT MEASUREMENTS OF THE 211.2 keV ($^{3}/_{2}^-$) AND 239.8 keV ($^{5}/_{2}^-$) STATES OF ^{193}Pt. Kugel, H. W.; (Univ. of Wisconsin, Madison); Borchers, R. R.; Kalish, Rafael. Nucl. Phys., A137: 500-10(1969).

The magnetic moments of the 211.2 keV ($^{3}/_{2}^-$, τ = 0.097 nsec) and 239.8 keV ($^{5}/_{2}^-$, τ = 0.332 nsec) states were measured by recoiling Coulomb excited Pt nuclei into a polarized iron backing foil and observing the precession of the γ-ray angular correlations. The γ-rays were detected in coincidence with backscattered particles with a Ge(Li) detector. The g-factors were deduced from $\omega\tau$ values after applying corrections for the transient magnetic fields which act on recoiling nuclei. The results are g(211.2 keV) = 0.16(6) and g(239.8 keV) = 0.07(2) and do not agree with the predictions of the core excitation model. (auth)

6898 LIFETIMES OF EXCITED STATES IN ^{193}Ir. Lindskog, J.; Vaelivaara, K.- G.; Awwad, Z.; Haegglund, S. E.; Marelius, A.; Phil, J. (Univ. of Uppsala). Nucl. Phys., A137: 511-19(1969).

The lifetimes of four excited states in ^{193}Ir were measured by a delayed coincidence technique. The results are: 73.0-keV level, $T_{\frac{1}{2}}$ = 6.3 ± 0.2 ns; 138.9-keV, $T_{\frac{1}{2}}$ = 74 ± 11 ps; 180.0-keV, $T_{\frac{1}{2}}$ = 78^{+21}_{-18} ps; 460.5-keV, $T_{\frac{1}{2}}$ = 14 ± 9 ps. Furthermore, upper limits of the lifetimes of the 557.3- and 559.2-keV levels were shown to be 50 ps and 200 ps, respectively. A comparison is made between experimental and theoretical transition probabilities for the transitions de-exciting the 180.0-keV level. (auth)

6899 RADIATIVE CAPTURE OF NEUTRONS BY THE 6.24, 15.5, AND 29.7 eV RESONANCES IN ^{121}Sb AND THE 21.6 eV RESONANCE IN ^{123}Sb. Ing, H.; Kukoc, A.; King, J. D.; Taylor, H. W. (Univ. of Toronto). Nucl. Phys., A137: 561-78(1969).

Gamma rays from neutron capture in four low-energy resonances of natural antimony were studied with a two-dimensional data collection technique. The investigation has yielded 6808 ± 3 and 6470 ± 3 keV for the neutron-separation energies of ^{122}Sb and ^{124}Sb, respectively. Twelve levels in ^{122}Sb and two in ^{124}Sb were identified on the basis of primary transitions and a number of low-energy transitions. The question of the reaction mechanism for the neutron capturing process is discussed. (auth)

6900 THE RADIOACTIVE DECAYS OF 6.7 min ^{179m}W AND 38 min ^{179}W. Konijn, J. (Instituut voor Kernphysisch Onderzoek, Amsterdam); Meijer, B. J.; Klank, B.; Ristinen, R. A. Nucl. Phys., A137: 593-605(1969).

The decays of 6.7 min ^{179m}W and 38 min ^{179}W were studied by means of high resolution γ-ray and electron spectroscopy using Ge(Li) and Si(Li) detectors, a broad-range transport solenoid electron spectrometer and γ–γ coincidences with Ge(Li) detectors. The decay of 38 min ^{179}W occurs by a fast beta transition (log ft 4.6) and by a first-forbidden beta transition (log ft 6.9) followed by a 30.7-keV and by a 133.9-keV γ-transition, respectively. The [521]↓$^{1}/_{2}^-$ 6.7 min ^{179m}W decays mainly by an isomeric transition of 221.5 keV (M3) and a competing 101.6 keV (E4)-120.1 (E2) keV cascade to the ^{179}W ground state. A small fraction of the decay of the 6.7 min isomer is observed to proceed by beta transitions to levels in ^{179}Ta. The results are interpreted in terms of the Nilsson model and the following intrinsic proton states are proposed in ^{179}Ta: [404]↓$^{7}/_{2}^+$ ground state; [514]↑$^{9}/_{2}^-$ 30.67 keV; [402]↑$^{5}/_{2}^+$ 238.7 keV; [411]↓$^{1}/_{2}^+$ 520.4 keV; and [541]↓$^{5}/_{2}^-$, K= $\frac{1}{2}$ at 741.5 keV. The [541]↓$^{1}/_{2}^-$ band is observed to have approximately the same large decoupling parameter (a > 4) as has been found in ^{173,175}Lu. (auth)

6901 MOMENT OF INERTIA OF THE FISSION ISOMER. Krumlinde, J. (Lund Inst. of Tech., Sweden). Phys. Lett., 30B: 221-2(Oct. 13, 1969).

The moment of inertia of some nuclides in the actinide region are calculated by means of the cranking formula. Results are given both for the ground state and for the fission (shape) isomeric state. (auth)

6902 DECAY OF ^{152}Eu. Kemnitz, P.; Funke, L.; Kaun, K.- H.; Sodan, H.; Winter, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A137: 679-88(1969).

The level scheme of ^{152}Gd was investigated in the decay of 19 min ^{152}Eu. Singles γ-ray spectra and γγ-coincidences were measured using Ge(Li) and scintillation detectors. Many new γ-transitions were observed. A decay scheme is proposed involving 18 excited states in ^{152}Gd, 16 of them are confirmed by coincidences. The quantum numbers of the levels are associated with intrinsic and collective modes of excitation in the framework

of the Nilsson model. Levels at 744.4 and 1128 keV are interpreted as mixed Nilsson states $3/2^+[402]$ and $3/2^+[651]$. (auth)

6903 DECAY OF ^{188}Au AND ^{190}Au. Naumann, R. A.; Petry, R. F.; Evans, J. S. (Princeton Univ., N. J.). Nucl. Phys., A137: 689-92(1969).

The decay of ^{188}Au and ^{190}Au was studied and several new levels were added to the previously published level schemes of ^{188}Pt and ^{190}Pt. (auth)

6904 LIFETIME MEASUREMENTS IN ^{187}Re AND ^{189}Os. Andrejtscheff, W.; Dubbers, F.; Schilling, K.- D.; Stary, F. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A137: 693-6(1969).

The half-lives of the excited states 618 keV in ^{187}Re and 69.6 keV in ^{189}Os were determined as $T_{1/2}$ (618 keV) = 0.52 ± 0.03 ns and $T_{1/2}$ (69.6 keV) = 1.7 ± 0.1 ns. Comparisons with Nilsson and Weisskopf estimations are performed. (auth)

6905 SHORT-LIVED ^{123}Sn AND ^{125}Sn FROM THERMAL-NEUTRON FISSION OF ^{235}U. Erdal, B. R. (Washington Univ., St. Louis); Wahl, A. C.; Dropesky, B. J. Contracts AT(11-1)-1162; W-7405-eng-36. J. Inorg. Nucl. Chem., 31: 3005-9(Oct. 1969).

Isotopic separation of 40.1-min ^{123}Sn and 9.6-min ^{125}Sn from other tin fission products allowed determination of their fission yields and study of the chemical states of ^{123}Sn that are formed in fission. The yields determined are 0.0141 ± 0.0012% for 40.1-min ^{123}Sn, 0.0135 ± 0.0014% for 9.6-min ^{125}Sn, ~0.062% for 2.1-hr ^{127}Sn, and ~0.30% for ^{128}Sn. It was also determined that 54 ± 2% of 40.1-min ^{123}Sn is formed in the +2 oxidation state (the rest being in the +4 state) in an aqueous solution containing 1.0 M HCl, 0.21 M HF, 0.013 M UO_2^{2+}, 0.011 M Sn(II), and 0.011 M Sn(IV). This value for ^{123}Sn is larger than that for 27-hr ^{121}Sn formed under the same chemical conditions and shows that the fraction of tin formed in the +2 state by beta decay is not constant but depends on the characteristics of the beta decay process. (auth) (UK)

6906 RESONANCE PARAMETERS AND AVERAGE CAPTURE CROSS SECTIONS OF GADOLINIUM. Friesenhahn, S. J.; Costello, D. G.; Lopez, W. M.; Fricke, M. P.; Carlson, A. D. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 754-5(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6907 AN ABSOLUTE MEASUREMENT OF $\nu(^{252}Cf)$ AND ITS RELATIONSHIP TO THE NEUTRON YIELD FOR FISSIONABLE MATERIALS. De Volpi, A.; Porges, K. G. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 759(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6908 GAMMA-RAY SPECTRA FOLLOWING CAPTURE OF EPITHERMAL NEUTRONS. Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 922 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6909 ^{233}U DOPPLER BROADENING BY SINGLE- AND MULTILEVEL RESOLVED RESONANCE PARAMETERS. Boroughs, Glen (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 750-1(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6910 MULTIGROUP RESONANCE CROSS SECTIONS FOR SLABS OF TUNGSTEN AND DEPLETED URANIUM FOR USE IN SHIELDING CALCULATIONS. Lahti, Gerald P.; Westfall, Robert M. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 12: 964(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6911 GAMMA ENERGY SPECTRUM ABOVE 1 MeV CAUSED BY THERMAL-NEUTRON ABSORPTION IN ^{238}U. Booth, R. S.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 929(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6912 DETERMINATION OF THERMAL-NEUTRON CAPTURE-GAMMA YIELDS. Harper, Thomas L. Jr.; Rasmussen, Norman C. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 926-7(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6913 EVALUATION OF THE FISSION NEUTRON SPECTRUM OF ^{233}U. Steen, N. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 651-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6914 FISSION CROSS-SECTION RATIO OF ^{239}Pu AND ^{235}U IN THE NEUTRON ENERGY RANGE 150 TO 1400 keV. Poenitz, W. P. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 742-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6915 INTEGRAL MEASUREMENT OF THE THORIUM TOTAL CROSS SECTION. Green, L. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 745(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6916 NEUTRON INELASTIC SCATTERING FROM ^{90}Zr. Glickstein, S. S.; Tessler, G.; Goldsmith, M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 747-8(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6917 CONSEQUENCES OF VARIOUS PROPOSED NUCLEAR DATA. Staub, Alan; Swaja, R. E. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 748(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6918 RESONANCE PARAMETERS AND RESONANCE CAPTURE INTEGRAL OF ^{151,153}Eu AND ^{152,154}Sm. Rahn, F. J.; Ho, C. (Columbia Univ., New York). Trans. Amer. Nucl. Soc., 12: 749(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6919 DOPPLER-BROADENED QUASI-RESONANCE FISSION CROSS SECTIONS: APPLICATION TO ^{235}U. Shea, T. E.; Purohit, S. N. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 751-2(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6920 EVALUATION OF NEUTRON CAPTURE AND FISSION CROSS SECTIONS FOR ^{233}U. Steen, N. M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 752-3 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6921 CORIOLIS COUPLING ANALYSIS OF THE CROSS SECTIONS FROM (d,p) AND (d,t) REACTIONS. Kanestroem, L.; Tjoem, P. O. (Univ. of Oslo). Nucl. Phys.; A138: 177-99 (1969).

The influence of the Coriolis coupling on the (d,p) stripping and (d,t) pickup cross sections was studied for several nuclei in the mass region 155 to 171. The calculated energies, cross sections and wave functions are tabulated for ^{155}Gd, ^{163}Dy, ^{165}Er, ^{165}Er, ^{167}Er, ^{169}Er, ^{169}Yb and ^{171}Yb, where four to eight negative parity bands were included in the calculations. The inclusion of the coupling in the calculations can in many cases improve the agreement between the experimental and theoretical results. (auth)

6922 ISOMERS IN ^{156}Gd, ^{172}Yb, AND ^{182}W. Nordhagen, R.; Diamond, R. M.; Stephens, F. S. (Univ. of California, Berkeley). Nucl. Phys.; A138: 231-40(1969).

With pulsed beam and electronic timing techniques, isomers in ^{156}Gd ($t_{1/2}$ = 2.7 ± 0.1 μsec), ^{172}Yb ($t_{1/2}$ = 3.6 ± 0.1 μsec) and ^{182}W ($t_{1/2}$ = 1.4 ± 0.1 μsec) were identified. Information on their decays and some tentative spin assignments are given. (auth)

6923 HYPERFINE FIELDS AT Pb IN Fe, Co, AND Ni LATTICES AND THE g-FACTOR OF THE FIRST 5^- STATE IN ^{208}Pb. Bowman, J. D.; Zawislak, F. C. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Phys.; A138: 90-6(1969).

The integral-reverse-field method of the perturbed angular correlation technique was used to determine the hyperfine magnetic fields acting at Pb nuclei embedded in iron, cobalt and nickel lattices. The measurements were performed involving the 1064 to 570 keV γ-γ cascade in ^{207}Pb. The results when compared with measurements in an external magnetic field give for the hyperfine fields at Pb in Fe, Co and Ni +660 ± 45, +430 ± 32 and +115 ± 15 kG respectively. Making use of the hyperfine fields at Pb the ratio $g(5^-)/g(3^-)$ between the g-factors of the second and first excited

states in ^{206}Pb was measured to be +0.036 ± 0.006. This ratio, and the known g-factor of the 3$^-$ state yield g(5$^-$) = +0.021 ± 0.007. Results for the hyperfine magnetic fields on ^{208}Pb using sources of ^{228}Th diffused into Fe, Co and Ni lattices are discussed. (auth)

6924 TIME DIFFERENTIAL ANGULAR CORRELATION MEASUREMENTS ON ^{160}Dy AND THE ELECTRIC QUADRUPOLE MOMENT OF THE FIRST EXCITED STATE. Forker, M.; Wagner, H. F.; Schmidt, G. (Univ., Bonn). Nucl. Phys.: A138: 97-104(1969).

The statistical perturbation of the angular correlations of the 1178 to 87 keV cascade and the 879 to 87 keV cascade of ^{160}Dy was investigated by time differential measurements. Liquid sources of 3$^+$ ions of ^{160}Tb in 1N perchloric acid, 1N sulfuric acid, and 0.01, 1.0, 3.0 and 10.0N hydrochloric acid were used. In all cases the measured angular correlation coefficients A_2 and A_4 are well described by single exponential functions. For the electric quadrupole-moment of the first excited state, the value $(1 - R)\,Q_{sp}$ = 1.67 ± 0.46 b was derived. This result is in agreement with Coulomb excitation data. (auth)

6925 ON THE INTERPRETATION OF THE ENERGY LEVELS OF ^{170}Lu. Treherne, J. (Laboratoire Joliot Curie, Orsay, France); Piepenbring, R. Nucl. Phys.; A138: 105-14 (1969).

Some theoretical interpretations of the main properties of the level scheme of ^{170}Lu and some information concerning the neutron-proton residual interaction are given. (auth)

6926 LEVELS IN ^{110}Cd POPULATED IN THE DECAY OF 60 min ^{110g}In. Sarantites, Demetrios G. (Washington Univ., St. Louis); Johnson, Noah R.; Boyd, H. W. Contract AT(11-1)-1760. Nucl. Phys.; A138: 115-32(1969).

The level structure of ^{110}Cd was investigated from the decay of 69 min ^{110g}In. Singles γ-ray spectra were taken with a large-volume, high-resolution Ge(Li) detector. Extensive γ-γ coincidence measurements were made with both NaI–NaI and NaI–Ge(Li) arrangements. From these data it was concluded that levels at 657.5, 1475.2, 1540.9, 1731.5, 1783.3, 1809.0, 2078.8, 2355.5, 2463.1, 2786.5, 2868.3, 2974.1, 3077.9, 3101.4, 3193.8, 3313.3, 3402, 3451.1, 3464.3, 3474, 3596, 3701 and 3770 keV in ^{110}Cd are populated in the decay of 69 min ^{110g}In. From log ft values determined in this work and from γ-ray intensity information, limits were placed for the J$^\pi$ values of many levels. The half-life of ^{110g}In was measured and found to be 69.1 ± 0.5 min. (auth)

6927 NEUTRON SINGLE-HOLE STATES IN ^{149}Sm, ^{157}Gd, AND ^{196}Au INVESTIGATED BY (p,d) REACTIONS. Yagi, K. (Osaka Univ.): Saji, Y.; Ishizaki, Y.; Ishimatsu, T. Nucl. Phys.; A138: 133-44(1969).

In order to continue studies of neutron single-hole states in nuclei of $50 \leq N \leq 126$, (p,d) reactions on ^{150}Sm, ^{158}Gd and ^{197}Au were investigated by the use of a proton beam of 55 MeV. Emitted particles were analyzed with a broad-range magnetic spectrometer and detected with a 200 proportional counter system. Angular distributions of 39 deuteron groups are analyzed with the aid of the DWBA method. The l-values are assigned, and J$^\pi$ values and the spectroscopic factor for each state are obtained. Many new excited states were found and their J$^\pi$ values are given. Energy shifts of the neutron single-hole states of $3p_{\frac{1}{2}}$, $2f_{\frac{5}{2}}$, $3p_{\frac{3}{2}}$, $1i_{\frac{13}{2}}$, $2f_{\frac{7}{2}}$ and $1h_{\frac{9}{2}}$ observed between ^{207}Pb, ^{205}Pb and ^{196}Au are interpreted on the basis of effective proton-neutron interactions. The observed energy shifts are reproduced rather well by the use of the interaction $V_{pn} = (V_0 + V_1\sigma_p\cdot\sigma_n)\delta(r_p - r_n)$ and of the harmonic-oscillator wave functions except for the case of the $p_{\frac{1}{2}}$ state. In order to explain the shift of the $p_{\frac{1}{2}}$ state relative to the $p_{\frac{3}{2}}$ state, it is necessary to introduce some spin-dependent interactions such as tensor interactions and/or two-body spin-orbit interactions. (auth)

6928 DETERMINATION OF THE RATIO OF THE QUADRUPOLE MOMENTS OF THE 1174 keV AND THE 78 keV LEVELS IN ^{172}Yb. Forker, M.; Wagner, H. F. (Univ., Bonn). Nucl. Phys.; A138: 13-18(1969).

The statistical perturbation of γγ-angular correlations proceeding via the 2$^+$ rotational and the 3$^+$ isomeric states in ^{172}Yb were investigated. The attenuation in the 2$^+$ state is consistent with combined electric and magnetic hyperfine interactions due to the 4f electronic shell. The ratio of the quadrupole moments of the two nuclear states was determined as Q^{3+}/Q^{2+} = 1.55 ± 0.23. (auth)

6929 PROPERTIES OF ^{119}Sb IN THE SEMI-MICROSCOPIC MODEL. Lopac, V. (Ruder Boskovic Inst., Zagreb). Nucl. Phys.; A138: 19-32(1969).

The semi-microscopic model of the nucleus assuming a proton coupled to a quadrupole vibrator is applied to antimony. The stability of the results is investigated. The calculated energies, spectroscopic factors and electromagnetic properties of the low-lying states are in satisfactory agreement with experiments. (auth)

6930 STATES OF ^{171}Yb FROM DECAY OF ^{171}Lu. Barneoud, D.; Boutet, J.; Gizon, J.; Valentin, J. (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A138: 33-48(1969). (In French).

The energy levels of ^{171}Yb were studied from the electron capture decay of 8.3 d ^{171}Lu by means of Ge(Li) detectors, and gamma-gamma coincidence techniques. Properties of the levels are discussed in terms of the Bohr and Mottelson unified model and the single-particle Nilsson model. (auth)

6931 PROSPECTS FOR FURTHER CONSIDERABLE EXTENSION OF THE PERIODIC TABLE. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). J. Chem. Educ., 46: 626-34(Oct. 1969).

Predictions on the chemical properties of the transactinide elements are offered. Various calculations on the electronic structure of transactinide elements are surveyed. Recent experimental work concerning searches for elements 104 and 105 is described. Theories on the nuclear stability of superheavy elements are discussed and the best prospects for stability are mentioned. Searches for Z = 110 through 114 are briefly discussed and the methods for synthesis of superheavy elements are examined. (J.W.R.)

6932 INDEPENDENT YIELDS OF ^{82}Br, ^{86}Rb, ^{136}Cs, AND ^{150}Pm IN SPONTANNEOUS FISSION OF ^{252}Cf. Von Gunten, H. R.; Flynn, K. F.; Glendenin, L. E. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 31: 3357-61(Nov. 1969).

Independent fission yields in the spontaneous fission of ^{252}Cf were determined by radiochemical techniques for the shielded nuclides ^{82}Br, ^{86}Rb, ^{136}Cs and ^{150}Pm. They were found to be $<3.7 \times 10^{-6}$%, 5.4×10^{-6}%, 2.2×10^{-2}% and 2.0×10^{-2}%, respectively. The corresponding fractional chain yields lead to empirical Zp (most probable charge) values which are in good agrement with Zp values determined by physical methods (K x-rays). (auth) (UK)

6933 PRODUCTION OF HEAVY NUCLIDES IN 440-MeV PROTON FISSION OF URANIUM. Hogan, James J.; Sugarman, Nathan (Univ. of Chicago). Phys. Rev., 182: 1210-35(June 20, 1969).

The recoil properties of 20 nuclides of mass about 140 formed in the 440-MeV proton fission of uranium were determined. The average kinetic energy, cascade deposition energy, and angular anisotropy for each fission product were calculated from the recoil results. The kinetic energy and excitation energy of the primary fragments leading to these fission products, and the total kinetic energy and excitation energy of the primary-fragment pair, were calculated from those of the fission products. The primary-fragment results indicate a dependence of the deformation of the fissioning nucleus on its excitation energy, and explain the trends observed in the kinetic energy and cascade deposition energy of the fission products. The theory used to explain the angular distribution of fission products produced by low-energy (<50 MeV) bombarding projectiles was applied successfully in the explanation of the angular anisotropies observed at 440 MeV. The charge dispersion of the fission products of mass 139 was determined, and was fitted by a Gaussian curve with a full width at half-maximum of 3.2 charge units. The primary fragments leading to isobaric fission products differ from each other by two mass units per charge unit, and are more constant in neutron-to-proton ratio than the fission products. (auth)

6934 STUDY OF THE ENERGY LEVELS OF ^{205}Tl USING THE (γ,γ') REACTION. Moreh, R.; Wolf, A. (Nuclear Research Centre-Negev, Beer Sheva, Israel). Phys. Rev., 182: 1236-43 (June 20, 1969).

Both elastic and inelastic scatterings of monochromatic photons were used for studying the energy levels of ^{205}Tl; the photons were produced by thermal-neutron capture in iron, and the resonantly scattered spectrum was measured using Ge(Li) detectors. The scattering isotope was identified by using an isotopically enriched thallium target. The energy of the resonance level in ^{205}Tl was found to be 7.646 MeV. The spectral shape of the scattered radiation was found to have a strong intensity bump above about 4.5 MeV. Energies and intensities of several γ lines were measured in the region 1.0 to 7.7 MeV. Assuming the high-energy lines to be primary transitions deexciting the resonance level, 25 energy levels were found from the ground state up to 3.4 MeV, 8 of which may be identified with recently reported levels. By measuring the angular distribution of the scattered radiation, the spin of the scattering level was found to be $\frac{1}{2}$. The width of the resonance level was determined and was found to be Γ = 0.98 ± 0.09 eV, and Γ_0/Γ = 0.58. The E1 character of the scattered radiation was inferred from the systematics of the radiation widths of highly excited levels, and the resonance level was interpreted as being associated with the tail of the giant electric-

dipole resonance. The ^{205}Tl levels are discussed in terms of the predictions of the shell model. The anomalous intensity bump in the γ spectrum is discussed in the light of similar bumps obtained in the (n,γ) reaction on nuclei in the same mass region. (auth)

6935 ENERGETICS AND MASS DISTRIBUTION OF FISSION FRAGMENTS IN TRITON- AND PROTON-ACCOMPANIED FISSION OF ^{252}Cf. Nardi, Eran (Israel Atomic Energy Commission, Yavne. Weizmann Inst. of Science, Rehovot, Israel); Gazit, Yaacov; Katcoff, Seymour. Phys. Rev., 182: 1244-51 (June 20, 1969).

The kinetic energies of the fission fragments and of the light particle emitted in triton- and proton-accompanied fission of ^{252}Cf were measured in a four-parameter correlation experiment. Assuming that the average total kinetic energy of the fragments in long-range alpha fission (LRA fission) is 172.9 MeV, this value in triton-accompanied fission was found to be 173.5 ± 0.3, while in proton-accompanied fission the value of 173.6 ± 0.5 was obtained. The mass distribution in triton-accompanied fission was found to be very similar to that in LRA fission, while this distribution for proton-accompanied fission is somewhat different from that in both binary and LRA fission. In addition, the degree of correlation between the average total fission-fragment energy and the particle energy was measured. (auth)

6936 LOW-YIELD PRODUCTS FROM FISSION OF ^{232}Th, ^{235}U, AND ^{238}U WITH 14.8-MeV NEUTRONS. Nethaway, D. R.; Mendoza, B.; Voss, T. E. (Univ. of California, Livermore). Phys. Rev., 182: 1251-9(June 20, 1969).

The fission yields of a number of products from 14.8-MeV neutron fission of ^{232}Th, ^{235}U, and ^{238}U were measured. The fission products chosen are all on the wings of the mass-yield curves and are formed in very low yield. They extend from ^{58}Ni to ^{72}Zn and from ^{153}Sm to ^{172}Er. The amount formed of each product was determined by absolute β and γ counting techniques. The number of fissions in each target was calculated from the target mass, the fission cross section, and the neutron flux. The neutron flux was measured by means of the ^{89}Y(n,2n)^{88}Y reaction with Y_2O_3 monitor foils. The results show that, within experimental uncertainty, the wings of the mass-yield curves are consistent with Gaussian functions. These Gaussian curves allow interpolation and prediction of fission yields of unmeasured products. The widths of the mass-yield curves for ^{235}U and ^{238}U are almost the same, while that of ^{232}Th is significantly narrower. The centers of the Gaussian distributions are shifted to higher mass numbers than would be predicted from the average total neutron emission in fission. The effect of target impurities on the measured fission yields was shown to be generally small. An attempt was made to examine the effect of nuclear charge distribution on the mass yields. This effect, which would cause the observed fission yields to be less than the total mass yield, is probably significant only for the yields of masses 166 and 172. As a check on our experimental method we also remeasured the fission yields of three products near the peaks of the mass-yield curves. The results are consistent with those reported before. (auth)

6937 γ–γ DIRECTIONAL CORRELATIONS IN THE DECAY OF ^{192}Ir. Khan, M. Y.; Wyly, L. D.; Braden, C. H.; Patronis, E. T. Jr. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 182: 1259-64(June 20, 1969).

γ–γ directional correlations have been measured for the following cascades in the decay of 74-day ^{192}Ir: 468-417 keV, A_2 = −0.12 ± 0.03, A_4 = 0.11 ± 0.06, $|\delta|$(417 keV) > 8; 588-612 keV, A_2 = 0.09 ± 0.03; 604-316 keV, A_2 = −0.49 ± 0.03, δ(604 keV) ≈ 2; 308-612 keV, A_2 = −0.10 ± 0.02, δ(308 keV) = −8 ± 2; 588-296 keV, A_2 = 0.00 ± 0.03, δ(296 keV) >4 or <−20; 484-206 keV, A_2 = −0.28 ± 0.03, δ(484 keV) = 10(+10, −3); 374-206 keV, A_2 = 0.10 ± 0.03. The results (1) support spin assignments of 3 and 4 for the 921- and 1200-keV levels, respectively, in ^{192}Pt, (2) are consistent with spin 4 for the 580-keV level in ^{192}Os, and (3) indicate spin 3 for the 690-keV level in ^{193}Os. (auth)

6938 BETA-VIBRATIONAL BAND IN ^{152}Sm. Mukherjee, P.; SenGupta, A. K. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 182: 1265-6(June 20, 1969).

The intensities of the γ rays (444.1-, 563.9-, 656.1-, 688.0-, and 810.5-keV) between the various levels of the β-vibrational band and the ground-state rotational band of ^{152}Sm are measured from an analysis of high-resolution (2.6-keV) γ-ray spectra of the 98%-enriched 12.4-yr ^{152}Eu decay. Upper limits of the intensities of the $4_\beta^+ \rightarrow 6^+$ and $4_\beta^+ \rightarrow 2^+$ transitions are also given. From the α_k of the 444.1-keV transition, the $2_\beta^+ \rightarrow 4^+$ branching is shown to be less than 5% of the total 444.1-keV γ intensity. A small but definite broadening of the 810.5-keV photopeak is observed. From these observations it is concluded that the reported B(E2) ratios for these transitions may have to be changed considerably. (auth)

6939 SINGLE AND MULTITRANSFER REACTIONS INDUCED BY 86-MeV ^{12}C IONS ON SILVER NUCLEI. Galin, J. (Institut de Physique Nucleaire, Orsay, France); Gatty, B.; Lefort, M.; Peter, J.; Tarrago, X.; Basile, R. Phys. Rev., 182: 1267-76(June 20, 1969).

Heavy particles from silver targets bombarded by ^{12}C heavy projectiles have been identified using a counter telescope and bidimensional analysis of ΔE and E data. Energy distributions have been measured for Li, Be, B, C, N, and O nuclei. Angular distributions exhibit a maximum which is related to the distance of closest approach. The largest cross sections are observed for ^{11}B (−1p) and ^{13}C (+1n) single transfer. It is emphasized that the total cross section for the loss of a proton by the projectile is 60 times the cross section for the pickup of a proton. The products of transfer reactions are mainly formed in excited states, but the angular distribution does not depend on the degree of excitation, at least for the lowest excited states. (auth)

6940 BETA DECAY OF ^{193}Os TO LEVELS IN ^{193}Ir. Cothern, C. R. (Univ. of Dayton, Ohio); Hennecke, H. J.; Manthuruthil, J. C.; Lange, R. C. Phys. Rev., 182: 1286-1303(June 20, 1969).

Energies and relative γ ray and internal-conversion intensities for several transitions in ^{193}Ir produced by the β decay of ^{193}Os have been measured. The γ-ray intensities were measured using a Ge(Li) spectrometer, and the internal-conversion intensities were measured using a 50-cm $\pi\sqrt{2}$ double-focusing iron spectrometer. The following precise energy-level values were determined: 73.03 ± 0.08, 138.92 ± 0.05, 142.02 ± 0.20, 179.97 ± 0.09, 361.84 ± 0.14, 441.0 ± 0.3, 460.62 ± 0.09, 557.45 ± 0.20, 559.48 ± 0.25, 659.8 ± 0.45, and 712.26 ± 0.13. The L-subshell ratios for the 73-, 106-, and 139-keV transitions provided the information necessary to normalize the relative γ-ray and internal-conversion intensities yielding internal-conversion coefficients. The following level spins and parities were determined: 139-keV level, $3/2^+$ or $5/2^+$; 142-keV level, $5/2$ or $7/2$; 357-keV level, $7/2$; 362-keV level, $1/2^+$, $3/2^+$, or $5/2^+$; and 460-keV level, $3/2^+$. The resulting decay scheme, multipolarities, and level spins and parities are discussed in terms of several nuclear models. The half-life of ^{193}Os was determined to be 30.0 ± 0.3 h. (auth)

6941 BINARY AND TERNARY FISSION OF ^{238}U INDUCED BY INTERMEDIATE-ENERGY ^{3}He IONS. MacMurdo, K. W.; Cobble, J. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 182: 1303-7(June 20, 1969).

Cross-section data for 33 nuclides have been obtained radiochemically and used to construct a mass-yield curve for the fission of ^{238}U induced by 31-MeV ^{3}He ions. The mass range studied was 24 ≤ A ≤ 212 and the yields varied over seven orders of magnitude. The data for ^{24}Na, ^{28}Mg, ^{31}Si, ^{38}S, ^{47}Ca, ^{199}Au, ^{209}Pb, and ^{212}Pb confirm the existence of ternary fission in compound-nuclear processes at intermediate energies, as previously reported from these laboratories. These data also establish the transition region between ternary and highly asymmetric binary processes at A ~ 45. Recoil-range data indicate some small but significant differences between ^{3}He- and ^{4}He-induced ternary fission. On the assumption that there is a peak in the ternary mass-yield curve at A ~ 24, the total ternary-fission cross section for 31-MeV ^{3}He ions on ^{238}U is ~3.3×10^{-30} cm^2, and $\sigma_{ternary}/\sigma_{binary}$ ~4.4×10^{-6}. (auth)

6942 HIGH-RESOLUTION PROTON SCATTERING ON ^{91}Zr AND THE CORE-EXCITATION MODEL. DuBard, James L.; Sheline, Raymond K. (Florida State Univ., Tallahassee). Contract AT(40-1)-2434. Phys. Rev., 182: 1320-8(June 20, 1969).

The reactions ^{90}Zr(p,p')^{90}Zr and ^{91}Zr(p,p')^{91}Zr have been studied with 12.0-MeV protons. Proton spectra were measured with a broad-range magnetic spectrograph at six reaction angles between 30° and 90°, sufficient to distinguish between L = 2 and L = 3 transitions. The ^{91}Zr spectrum is interpreted in terms of $d_{5/2}$, $s_{1/2}$, $d_{3/2}$, and $g_{7/2}$ neutron states coupling to the low-lying states of the ^{90}Zr core. The predictions of the core-excitation model are compared in detail with the data for the multiplets formed by the $d_{5/2}$ neutron coupling to the 2+ and 3− states in the ^{90}Zr core. (auth)

6943 ALPHA DECAY OF ^{227}U. Hahn, R. L.; Roche, M. F.; Toth, K. S. (Oak Ridge National Lab., Tenn.). Phys. Rev., 182: 1329-31(June 20, 1969).

The α spectrum of the ^{227}U decay chain, previously reported in 1952 by Meinke et al., was investigated by bombarding ^{231}Pa with protons from 35 to 54 MeV. The half-life of the parent nuclide ^{227}U was found to be 1.1 ± 0.1 min, in agreement with the earlier value of 1.3 ± 0.3 min. The α-particle energies in the decay chain were determined more precisely than in the

earlier study. In addition, some disagreement was found with the 1952 work. The nuclides and α-particle energies observed in the present investigation are as follows: ^{227}U, 6.87 ± 0.02 MeV; ^{223}Th, 7.33 ± 0.02 MeV; ^{219}Ra, 7.70 ± 0.02 MeV (relative intensity 0.7 ± 0.1) and 7.99 ± 0.02 MeV (0.3 ± 0.1); ^{215}Rn, 8.67 ± 0.02 MeV; and ^{211}Po, 7.46 ± 0.02 MeV. (auth)

6944 DISTRIBUTION OF NUCLEAR CHARGE IN LOW-ENERGY FISSION OF TRANSTHORIUM ELEMENTS. Notea, A. (Soreq Nuclear Research Center, Yavne, Israel). Phys. Rev., 182: 1331-40(June 20, 1969).

The variation of the nuclear charge dispersion σ in the thermal neutron fission of ^{235}U was examined in three limited product mass ranges. By using measured or estimated σ values and fractional chain yields, the "experimental" most probable charge values $Z_p(A)$ were derived. For chains outside the mass regions mentioned, the average dispersion $\sigma = 0.57 \pm 0.07$ was used. From the derived experimental $Z_p(A)$ values, a new empirical $Z_p(A)$ function covering the whole fission-product mass region was drawn. This empirical function agrees with all published experimental data. The way of estimating product yields from this function is described. The effects of closed shells on the shape of the curve are discussed. The empirical function is preserved for other types of low-energy fission, but is shifted by a constant $\Delta\delta$. A simple empirical relation for calculating $\Delta\delta$ is given. (auth)

6945 ^{92}Mo(p,p'γ) REACTION VIA ISOBARIC ANALOG RESONANCES. Lieb, K. P.; Hausmann, T.; Kent, J. J. (Univ. of Texas, Austin). Phys. Rev., 182: 1341-56(June 20, 1969).

Low-lying states in ^{92}Mo were excited by inelastic proton scattering via several isobaric analog resonances in ^{93}Tc. Angular distributions of the subsequent γ rays were measured between 0° and 140° and analyzed in the framework of Weidenmüller's theory in order to extract information on the partial waves of the outgoing protons. The partial widths obtained are compared with the results of coupled-channel calculations applied to the bound ^{93}Mo parent system. (auth)

6946 MAGNETIC MOMENTS OF ANTIMONY ISOTOPES AND OTHER NUCLEI. Pauling, Linus (Univ. of California, San Diego, La Jolla). Contract DA-31-124-ARO-D-257. Phys. Rev., 182: 1357-8(June 20, 1969).

Observed values of the magnetic moments of the antimony isotopes and related nuclei are shown to be compatible with a description of the nuclei as involving orbital angular momentum carried by a triton. It is found that both L_tS_p and L_tJ_p coupling types are needed for different nuclei. (auth)

Nuclear Theory

Refer also to abstracts 6706, 6740, 6767, 6866, 6891, 6892, and 6921.

6947 (AD-692138) NUCLEAR STRUCTURE RESEARCH. Annual Report, January 1–December 31, 1968. (Notre Dame Univ., Ind. Dept. of Physics). July 1969. Contract N00014-67-A-0242. 38p. CFSTI.

The annual progress report for 1968 on nuclear structure research at the University of Notre Dame Physics Department is presented. The installation and testing of the modified model FN Tandem accelerator and construction, improvement, and maintenance of the accelerator auxiliary equipment are discussed. Reports are given on the experiments being conducted. (USGRDR)

6948 (ITF-69-49) APPLICATION OF BEITMAN METHOD FOR THE FACTORIZATION OF TWO-PARTICLE AMPLITUDE IN A THREE BODY PROBLEM. Akhmathodzhaev, B. A.; Belyaev, V. B.; Vzhtsionko, E. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 15p. (In Russian). (CONF-690632-1). Dep. CFSTI (U. S. Sales Only).

From Conference on the Theory of Small-Nucleon Systems, Kiev, USSR.

A new method of separable representation of the two-particle t-matrix in the three-body problem is presented. The method has a strong convergency and can be applied to the solution of problems with an arbitrary short-range potential. The bound state energy of ^{3}H is calculated with a potential which describes $^3S_1$ and $^1S_0$-phase shifts in the range 0 to 400 MeV. (auth)

6949 (ITF-69-50) ABOUT THE SHAPE OF THE EVEN–EVEN NUCLEI. Filippov, G. F.; Steshenko, A. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 36p. (In Russian). (CONF-690632-2). Dep. CFSTI (U. S. Sales Only).

From Conference on the Theory of Small-Nucleon Systems, Kiev, USSR.

The binding energy, shape and internal quadrupole moments of the light even-even atomic nuclei are calculated with the help of density matrix constructed on one-particle wave functions of the anisotropic oscillator by the variational method. It is assumed that a pair potential of Gaussian type acts between nucleons. The results are represented in the form of tables and diagrams. (auth)

6950 (ITF-69-52) β-TRANSITIONS IN THE MODEL OF NON-AXIAL ODD NUCLEUS. Kashuba, I. E.; Ovcharenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Matrix elements and comparative decay periods for the allowed and first forbidden β-transitions are calculated in the framework of the non-axial odd nucleus model. Numerical calculations and comparison with experiment were carried out for the first order β-transitions ^{165}Dy → ^{165}Ho and ^{177}Lu → ^{177}Hf. (auth)

6951 COULOMB INDUCED FISSION. Beyer, Karin; Winther, Aa. (Univ. of Copenhagen). Phys. Lett., 30B: 296-9 (Oct. 27, 1969).

The Coulomb excitation of high β-vibrational states in fissionable nuclei are calculated quantum-mechanically and are used to estimate Coulomb fission cross sections. (auth)

6952 MASKING EFFECT OF MULTIPLE SCATTERING ON THE DETERMINATION OF THE TWO-NUCLEON CORRELATION FROM π^--ABSORPTION EXPERIMENTS. Bertini, H. W. (Oak Ridge National Lab., Tenn.). Phys. Lett., 30B: 300-2(Oct. 27, 1969).

Calculations of π^--meson absorption reactions by two-nucleon pairs within complex nuclei indicate that the ratio of escaping n-n to n-p pairs is considerably different from the ratio of n-p to p-p pairs that initially absorb the π^-. (auth)

6953 RENORMALIZATION OF THE EFFECTIVE TWO-NUCLEON INTERACTION BY CORE-POLARIZATION PROCESSES. Osnes, E. (NORDITA, Copenhagen. State Univ. of New York, Stony Brook); Warke, C. S. Phys. Lett., 30B: 306-10 (Oct. 27, 1969).

The contributions to the effective two-nucleon interaction from higher-order core-polarization processes were investigated using the random phase approximation for calculating the core-excitations. The calculation was applied to the oxygen region, and a significant difference was found with respect to the lowest-order estimate. (auth)

6954 MECHANISMS OF NUCLEON TRANSFER. da Silveira, R. (Institut de Physique Nucleaire, Orsay, France). Port. Phys., 5: 93-117(1968). (In French).

A theoretical approach of heavy ion transfer reactions is given using the Glauber approximation. (auth)

6955 APPROXIMATE METHOD IN NUCLEAR STRUCTURE CALCULATIONS: HARTREE–FOCK THEORY AND RANDOM-PHASE APPROXIMATION. da Providencia, J. (Univ., Coimbra). Port. Phys., 5: 71-92(1968).

The main concepts and mathematical methods of the Hartree-Fock method, the Tamm-Dancoff method, and the Random Phase Approximation are analyzed. (J.W.R.)

6956 FOUR-PARTICLE SYSTEM GROUND STATE. Olkhovskii, V. S. (Inst. of Theoretical Physics, Kiev. Kiev State Univ.); Recami, E. Nuovo Cim., 63B: 593-610(Oct. 11, 1969).

Calculations are performed for the bound states of four-particle systems, and particularly the fundamental level, by considering a rather general expression for the binary central attractive potential. First, a Hamiltonian expansion in the strong-coupling-constant approximation is used; and then recourse is made to the harmonic polynomial method. In the practical case, the first method is useful but does not reveal itself to be a very precise one; the second method confirms its value, as — under reasonable simplifications — it may be shown that the influence on the ground level of all the "partial waves" following the first ones is quite negligible. The result is not far from experimental values. In the particular case of Yukawa potentials and α-particle ground energy, the value obtained is very near to the one of previous authors. (auth)

6957 ISOBARIC ANALOGUE STATES IN NUCLEI OF MASS 18 AND 19. Murthy, M.; Waghmare, Y. R. (Indian Inst. of Tech., Kanpur). Nucl. Phys., A137: 579-84(1969).

An analysis of the energy difference of the isobaric triplet of mass number 18 and the isobaric quartet of mass number 19 is made. The energy differences are calculated by taking into account the electrostatic and electromagnetic effects, and also

those arising from a short range charge-dependent nucleon–nucleon potential. The excitation energy of the first T = ³/₂ level in ^{19}F and ^{19}Ne and the mass excess of ^{19}Na are calculated and the agreement with experimental results is found to be satisfactory. (auth)

6958 LINEAR-RESPONSE THEORY IN NUCLEON–NUCLEUS SCATTERING. Weigel, Manfred (Univ. of California, Berkeley). Nucl. Phys., A137: 629-40(1969).

It is shown that the transition amplitude for scattering of nucleons on a hole nucleus can be directly expressed by the linear response function. The correlations in the ground state were included. The structure of the transition amplitude was studied for an extended schematic model. Furthermore, a short summary of the linear-response theory is given to clarify the assumptions about the effective interaction. (auth)

6959 ANALYSIS OF THE THREE-NUCLEON TRANSFER REACTIONS IN THE PAIRING POTENTIAL MODEL. Kammuri, Tetsuo; Yoshida, Hiroshi (Osaka Univ.). Nucl. Phys., A137: 641-657(1969).

Three-nucleon transfer reactions are analyzed in the DWBA using the pairing potential model. The DWBA form factor is factorized into two parts. The first factor, the pairing potential, corresponds to the identical two-nucleon transfer part, and represents the coherent property of the three-nucleon transfer reaction. The second factor is associated with the transfer of the odd nucleon and is taken to be single-particle eigenfunctions in a Woods-Saxon potential. The calculations are shown to be successful in reproducing the experimental angular distributions of (α,p) and (p,α) reactions. The J dependence of the angular distributions for the $l = 1$ and $l = 3$ (α,p) transitions can be explained by including the spin–orbit interaction of a proton with a nucleus. On the other hand, a more detailed treatment of the nuclear structure is necessary to reproduce the experimental J effect of $l = 2$ (α,p) transitions. (auth)

6960 EFFECTIVE-RANGE FORMULA FOR TWO-BODY SCATTERING COUPLED TO A CLOSED SECONDARY CHANNEL. Kermode, Mark W. (McMaster Univ., Hamilton, Ont.). J. Math. Phys. (N. Y.), 10: 1953-6(Oct. 1969).

The multichannel effective-range formulas are extended to the case of a closed secondary two-body channel in which there is a repulsive Coulomb potential. (auth)

6961 PARTICLE–HOLE MATRIX: ITS CONNECTION WITH THE SYMMETRIES AND COLLECTIVE FEATURES OF THE GROUND STATE. Garrod, Claude (Univ. of California, Davis); Rosina, Mitja. J. Math. Phys. (N. Y.), 10: 1855-61(Oct. 1969).

A detailed study is made of the properties of the "particle-hole matrix" $G_{abcd} \equiv \langle g|(a^\dagger b - \rho_{ab})^\dagger (c^\dagger d - \rho_{cd})|g\rangle$, where $|g\rangle$ is a many-fermion ground state and ρ_{ab} is the 1-body density matrix. It is shown that the zero eigenvalues of the particle-hole matrix are intimately and simply related to the one-body symmetries of the ground state. It is also shown that the large eigenvalues of G_{abcd} are closely related to the collective features of the ground state. (auth)

6962 TEST FOR SU_4 SYMMETRY OF NUCLEI. II. GENERALIZATION OF THE EXCHANGE POTENTIALS IN THE THEORY OF SUPERMULTIPLETS. Burdet, G.; Maguin, C.; Partensky, A. (Faculte des Sciences, Lyon). Nuovo Cim.; 64B: 263-83(11 Dec 1969).

An interpretation of the invariants of the SU_4 algebra is given in terms of exchange potentials which generalize the spin and isospin exchange operators. The phenomenological coefficients of the mass formula deduced from the SU_4 symmetry show typical features in the neighborhood of nuclei with completely filled shells; these phenomena are interpreted as a change in the correlations between two, three and four particles within the nuclear Hamiltonian. (auth)

6963 STATISTICAL PROPERTIES OF THE RESONANCE PARAMETERS OF THE FISSILE ISOTOPES. de Saussure, G.; Perez, R. B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 753-4(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6964 CALCULATION OF THE GENERALIZED KAPUR–PEIERLS PARAMETERS BY EXPANSION OF THE REICH–MOORE MULTILEVEL FORMULA. Perez, R. B.; de Saussure, G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 750 (Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

6965 OFF-ENERGY-SHELL CONTINUATION OF THE TWO-NUCLEON TRANSITION MATRIX. Baranger, M.; Giraud, B.; Mukhopadhyay, S. K.; Sauer, P. U. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Phys.; A138: 1-12(1969).

For an uncoupled partial wave without bound state, the symmetric part $\sigma(k,k')$ of the half-shell T-matrix can be given arbitrarily. This in turn determines the entire T-matrix. Since $\sigma(k,k)$ is essentially the phase shift, the arbitrary part of T appears as a continuation into two dimensions of the phase shift function, symmetry being the only restriction. This formulation stays closer to experiment than the usual one, in which the arbitrary function is the potential $V(k,k')$. A practical method is given to go from σ to the entire T-matrix. (auth)

6966 PROTON OPTICAL POTENTIALS FROM 30 TO 180 MeV. Seth, Kiran (Nuclear Physics Lab., Oxford). Nucl. Phys.; A138: 61-72(1969).

Experimental data on the elastic scattering of protons by nuclei at energies from 30 to 180 MeV are analyzed to give an average optical potential. (auth)

6967 DIRECT INTERACTIONS IN NUCLEAR REACTIONS. Vladuca, G. (Univ., Bucharest). Stud. Cercet. Fiz., 21: 337-59(1969). (In Rumanian).

Study of nuclear reactions with polarized (oriented) beams or targets requires the use of a density matrix which may be expressed by means of irreducible Hermitian operators. A relation was derived to indicate the correlation between the reaction cross sections of the polarized and an unpolarized beam. The polarizations described by the statistical tensors are defined by "Bale's convention." The relation may be verified by means of a beam obtained in an elastic reaction or scattering which occurs before the reaction under study. More precise results are obtained by using polarized sources, e.g., the CERN, Harwell, Minnesota, and Saclay proton sources and the Basel, Oak Ridge, Saclay, and Yale deuteron sources. The high precision of these sources renders them suitable for the determination of optical parameters and optical tensorial potentials which describe the scattering processes for particles with a nonzero spin s. The angular correlations in direct reactions are also examined. (38 references). (TTT)

6968 THREE-PARTICLE CHANNELS IN NUCLEAR-REACTION THEORY. Tobocman, W. (Case Western Reserve Univ., Cleveland). Phys. Rev., 182: 989-98(June 20, 1969).

A new approach to the treatment of three-body channels in nuclear-reaction theory is proposed. The method is based on the R-matrix formalism. Instead of introducing three-particle final states as a new class of channels, it is suggested that they be described in terms of incoherent contributions from the various two-body channels having scattering-state residual-nucleus wave functions instead of the customary bound-state ones. The method is (a) illustrated with a simple one-dimensional three-body system, (b) applied to a general three-body system, and finally (c) used to set up a distorted-wave Born-approximation analysis of the general three-body system. (auth)

6969 THEORY OF PION–NUCLEUS SCATTERING LENGTHS. Moyer, LeRoy; Koltun, Daniel S. (Univ. of Rochester, N. Y.). Phys. Rev., 182: 999-1007(June 20, 1969).

The impulse or single-scattering approximation for zero-energy pion–nucleus scattering gives results in disagreement with the experimental scattering lengths obtained from pionic atoms. Multiple-scattering corrections are calculated in a simple nuclear model, and it is shown that double scattering of the pion can account for a major portion of the disagreement. The largest contributions involve incoherent excitation of the nucleus and are not included in most optical models. These contributions include the effect of nuclear binding on the scattering. (auth)

6970 PHOTONUCLEAR DISINTEGRATION AT HIGH ENERGIES (<350 MeV). Gabriel, T. A.; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Phys. Rev., 182: 1035-50 (June 20, 1969).

Calculations of high-energy ($40 \lesssim E_\gamma \lesssim 350$ MeV) photon-nucleus ($A \gtrsim 12$) collisions have been carried out. The results of the initial interaction of the photon with the nucleus are obtained either from Levinger's quasideuteron model or, when energetically possible, from one of the four-pion–nucleon states formed in photon-nucleon interactions. The effect of nucleon- (pion-) nucleus interactions that follow the initial photon interaction is taken into account by using an intranuclear-cascade model. The results of the calculations are compared with a variety of experimental data, and good agreement is obtained. (auth)

6971 MAGNETIC MOMENTS AND β-DECAY ft VALUES OF MIRROR NUCLEI. Sugimoto, Kenzo (Osaka Univ.). Phys. Rev., 182: 1051-4(June 20, 1969).

Under the assumption that isospin is a good quantum number, the available data on the magnetic moments and the β-decay ft values for isospin doublets have been analyzed. Systematic information concerning the distribution of angular momentum between the orbital angular momentum and the spin and between the protons and the neutrons of a nucleus has been obtained for the mirror nuclei. Favorable evidence for the mesonic exchange effect to the magnetic moment has been found. (auth)

6972 SINGLE-PARTICLE ENERGY LEVELS BASED ON THE VELOCITY-DEPENDENT POTENTIAL. Lodhi, M. A. K. (Texas Tech. Coll., Lubbock). Phys. Rev., 182: 1061-5(June 20, 1969).

An effective velocity-dependent nucleon–nuclear potential based upon a relatively realistic N–N interaction has been used in this work. This effective potential has been approximated by the analytically solvable Morse function in a simple way. The neutron energy states characterized by the Morse parameters have been calculated for nuclides with $2 \leq A^{\frac{1}{3}} \leq 7$ using the independent-particle model. The Morse parameters have been expressed as functions of A and l. The single-particle energy levels obtained from this work have been compared with the available data and other theoretical and numerical results. (auth)

6973 CONTINUITY OF PHASE SHIFT AT CONTINUUM BOUND STATE. Bolsterli, M. (Univ. of Minnesota, Minneapolis). Phys. Rev., 182: 1095-6(June 20, 1969).

When a separable potential has a bound state in the continuum, there are two possible definitions of the phase shift. It is shown that if the phase shift is chosen to be the boundary value of the phase of an analytic function, then it has a jump discontinuity of magnitude π at each continuum bound state. Some advantages of this definition, as opposed to one giving a continuous phase shift, are presented. (auth)

6974 INELASTIC SCATTERING CALCULATIONS WITH PROJECTED HARTREE–FOCK WAVE FUNCTIONS. Braley, Richard C.; Ford, William F. (Lewis Research Center, Cleveland). Phys. Rev., 182: 1174-85(June 20, 1969).

The 0^+-2^+ cross sections for inelastic proton scattering have been calculated for several target nuclei in the 2s-1d shell. Inelastic cross sections are calculated in the distorted-wave Born approximation. Hartree–Fock wave functions projected onto states of good angular momentum represent the initial and final states of the nucleus. The cross sections are generally correct in shape, but too small in magnitude; it is suggested that the latter feature results from the assumption of an inert core. To test this hypothesis, the ^{20}Ne cross section is recalculated using a 20-particle wave function. The result compares more favorably with experiment. (auth)

6975 NUCLEON–NUCLEUS OPTICAL-MODEL PARAMETERS, A > 40, E < 50 MeV. Becchetti, F. D.; Greenlees, G. W. (Univ. of Minnesota, Minneapolis). Phys. Rev., 182: 1190-1209 (June 20, 1969).

Proton–nucleus and neutron–nucleus standard optical-model parameters are given that represent, quite well, much of the elastic scattering data in the range A > 40, E < 50 MeV. These parameters were determined by fitting simultaneously a large sample of the available proton data, and independently, a large sample of the available neutron data. Explicit energy- and isospin-dependent terms were included and their coefficients obtained directly from the data analysis. The results are shown to be consistent with the range and strength of the central and isospin components of the two-body interaction. (auth)

6976 EFFECTS OF CHARGE EXCHANGE IN DIRECT REACTIONS. Coker, Rory; Tamura, Taro (Univ. of Texas, Austin). Phys. Rev., 182: 1277-85(June 20, 1969).

The inclusion of charge-exchange effects in direct-reaction theory is discussed, and a number of experimental results are then treated: the threshold effect in ^{90}Zr(d,p) and ^{92}Mo(d,p) excitation curves in the region of the (d,n) threshold to the analog of the parent state, and the behavior of the ^{90}Zr(d,n$\vec{p}$) and ^{92}Mo(d,n$\vec{p}$) total cross sections in the same region; Hamburger's data for ^{207}Pb(d,p)^{208}Pb; and, finally, the discrepancy between (d,n) and (^{3}He,d) spectroscopic factors for analog states in several light nuclei. The theory is successful in describing the threshold effect and Hamburger's data, but does not explain the discrepancy in spectroscopic factors. A number of methods of calculating the analog-residual-state wave functions are critically discussed. (auth)

6977 IMPROVED INVERSE GAP EQUATION AND QUASIPARTICLE THEORIES OF ODD AND EVEN TIN ISOTOPES. Alzetta, R. (Univ., Trieste, Italy); Weber, T.; Gambhir, Y. K.; Gmitro, M.; Sawicki, J.; Rimini, A. Phys. Rev., 182: 1308-19 (June 20, 1969).

The nuclear-structure properties of the odd and even tin isotopes are studied, making use of an improved inverse-gap-equation (IGE) method and the quasiparticle theories. The two-body nuclear force assumed is a realistic potential (or reaction matrix) renormalized for the core polarization, and two cases are considered: (a) the potential of Tabakin, and (b) the reaction matrix of Yale-Shakin. While most types of levels are obtained in good agreement with experiment, others sharply disagree with the data. Only poor agreement with experiment is obtained for the electromagnetic properties of some of the calculated states and for the inelastic electron-scattering form factors. Spectroscopic factors for the one- and two-nucleon transfer reactions are presented and discussed. A warning is given against too much optimism about the indiscriminate applicability of the IGE method. Possible explanations for the difficulties of the method are discussed. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 5710, 5711, and 5807.

6978 (DOCKET-1155-11) REVISION IN DRAIN PIPING FROM THE SHUTDOWN CONDENSER LOOP. LACBWR Provisional Operating Authorization DPRA-5. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 29 Oct 1969. 5p. Dep. CFSTI.

The proposed shutdown condenser loop drain piping revisions for the LaCrosse Boiling Water Reactor are described. Normal operation of the condenser loop is discussed. Connecting the drain line to the blowdown line which goes to the main condenser is proposed. Schematics show the proposed revision in loop flow and for the wiring for the loop. (M.L.S.)

6979 (DOCKET-1155-14) LOCATION OF DEFECT AND LEAK IN REACTOR FEEDWATER PIPING. LACBWR Incident Report No. DPC 69-1. (Dairyland Power Cooperative, La Crosse, Wis.). 13 Nov 1969. 5p. Dep. CFSTI.

The location of a defect in one of the feedwater injection nozzles in the La Crosse Boiling Water Reactor is discussed. Results of the evaluation of the cause are given; the corrective action taken is described. (M.L.S.)

6980 (DOCKET-1155-16) REPORT ON LACBWR FEEDWATER PIPING PROBLEMS. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Oct 1968. 186p. (ACNP-68513; ACNP-68513,1). Dep. CFSTI.

Includes Addendum, Feb 1969.

Details on the feedwater piping problems in the La Crosse Boiling Water Reactor are given. The original design of the feedwater piping system is shown by schematics. Hanger problems and bellows deformation are described. Stress and flexibility calculations are detailed. Flexibility test measurements are discussed; results are detailed. The addendum to the original report details of bellows-restraint measurements, field measurements of piping, and feedwater nozzle problems. Stresses associated with pump vibrations are analyzed. (M.L.S.)

6981 (DOCKET-50010-60) [DRESDEN NUCLEAR POWER STATION, UNIT 1]. Supplement to Proposed Change No. 20. (Commonwealth Edison Co., Chicago, Ill.). 26 Nov 1969. 2p. Dep. CFSTI.

Equation modifications for analysis of waste releases in the environment are presented. (D.C.C.)

6982 (DOCKET-50183-6) VALLECITOS SUPERHEAT REACTOR. Preliminary Hazards Summary Report. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 1 Feb 1961. 252p. (GEAP-3643). Dep. CFSTI.

Information on Vallecitos Superheat Reactor is given under the following broad topics: Summary and Conclusions; Facility Description; Operating and Emergency Procedures; and Safety Evaluation. (D.C.C.)

6983 (DOCKET-50213-23) CONNECTICUT YANKEE ATOMIC POWER PLANT. Provisional Operating License No. DPR-14; Technical Specifications, Change No. 11. (Connecticut Yankee Atomic Power Co., Hartford). 24 Nov 1969. 4p. Dep. CFSTI.

Modifications related to leakage rate tests schedules for the containment building are described. (D.C.C.)

6984 (DOCKET-50213-24) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. Order Extending Provisional Operating License Expiration Date. (Division of Reactor Licensing (AEC), Washington, D. C.). 3 Dec 1969. 2p. Dep. CFSTI.

6985 (DOCKET-50219-60) [OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1]. Provisional Operating License DPR-16; Technical Specifications, Change Request No. 1. (Jersey Central Power and Light Co., Morristown, N. J.). 11 Nov 1969. 12p. Dep. CFSTI.

Modifications for the safety limits on fuel cladding integrity are presented. Safety limits are plotted for reactor thermal power compared with coolant flow rate. (D.C.C.)

6986 (DOCKET-50219-61) [OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1]. Provisional Operating License DPR-16; Technical Specifications, Change Request No. 2. (Jersey Central Power and Light Co., Morristown, N. J.). 25 Nov 1969. 3p. Dep. CFSTI.

Modifications on the protective instrumentation requirements are presented. The modifications are requested due to increased power level testing. (D.C.C.)

6987 (DOCKET-50220-29) [NINE MILE POINT NUCLEAR STATION]. [Results of Pre-Operational Control Rod Scram Tests]. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 6 Dec 1969. 2p. Dep. CFSTI.

Modification of the inner rod drive strainers is described and monitoring procedures for the reactor water are listed. (D.C.C.)

6988 (DOCKET-50220-30) [NINE MILE POINT NUCLEAR STATION]. Provisional Operating License DPR-17. Technical Specifications, Change Request No. 2. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 9 Dec 1969. 5p. Dep. CFSTI.

Modifications in the fuel cladding integrity safety limit curves are presented. The safety limit curve is based on recirculation flow and thermal power. (D.C.C.)

6989 (DOCKET-50237-33) [DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3]. Description of Hot Functional Tests. (Commonwealth Edison Co., Chicago, Ill.). 4 Dec 1969. 10p. (DOCKET-50249-32). Dep. CFSTI.

Modifications related to the hot functional testing program are described. Procedures for the revised program are presented. (D.C.C.)

6990 (DOCKET-50237-34) [DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3). [Changes in High Pressure Coolant Injection System]. (Commonwealth Edison Co., Chicago, Ill.). 4 Dec 1969. 2p. (DOCKET-50249-33). Dep. CFSTI.

6991 (DOCKET-50244-31) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Provisional Operating License No. DPR-18; Technical Specifications, Change No. 1. (Rochester Gas and Electric Corp., N. Y.). 5 Nov 1969. 2p. Dep. CFSTI.

Modifications for increasing the drop time of control rods are described. Effects on the hazards of accident conditions are analyzed. (D.C.C.)

6992 (DOCKET-50245-18) MILLSTONE NUCLEAR POWER STATION, UNIT 1. [Preliminary Safety Analysis Report], Amendment 18. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 31 Oct 1969. 209p. Dep. CFSTI.

The flow-reference scram, provided for the Millstone Power Reactor, Unit 1, is described. Seismic design considerations for steam and feedwater piping and for instrumentation are discussed. The model for analysis of ECCS performance under accident conditions is outlined; peak fuel clad temperatures are calculated. Program testing of the relief valve actuators for the containment system and steam system are detailed; raw data are included. Provisions for net positive suction head for the low pressure coolant injection pumps are described. Emergency Core Cooling System (ECCS) temperature design bases are given; design data are tabulated. Details of cavitation tests of the ECCS pumps are given; raw data are included. Seismic design criteria for the buildings and structures are summarized; results of analyses are tabulated. (M.L.S.)

6993 (DOCKET-50245-19) MILLSTONE NUCLEAR POWER STATION, UNIT 1. [Final Safety Analysis Report], Amendment 19. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 12 Nov 1969. 16p. Dep. CFSTI.

Control rod reactivity worth calculations are presented. Hurricane flooding possibilities are analyzed. Stress calculations for piping systems are included. Stress calculations for buildings subjected to tornado winds and seismic loadings are also included. (D.C.C.)

6994 (DOCKET-50245-22) MILLSTONE NUCLEAR POWER STATION, UNIT 1. [Final Safety Analysis Report], Amendment 21. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 25 Nov 1969. 17p. Dep. CFSTI.

Flood protection systems are described. The turbine building

secondary cooling water system is analyzed. Electrical systems for emergency conditions are described. (D.C.C.)

6995 (DOCKET-50247-12) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. [Preliminary Safety Analysis Report], Amendment 12. (Consolidated Edison Co. of New York, Inc., New York). 21 Nov 1969. 87p. Dep. CFSTI.

Effects of tornado stresses on the superheater stack are analyzed. Leak detection systems for Class 1 fluid systems are described. Protection system design features are presented. Actuation logic circuits are included for engineered safety systems. Offsite power supply system actuation is described. Emergency power systems are also described. The waste disposal system is illustrated. Reactor coolant isotope discharge rates into the Hudson River are listed. (D.C.C.)

6996 (DOCKET-50249-22) DRESDEN NUCLEAR POWER STATION, UNIT 3. Plant Design and Analysis Report, Amendment 6. (Commonwealth Edison Co., Chicago, Ill.). 19 May 1967. 20p. Dep. CFSTI.

The electrical system is described. Standby diesel generator system design parameters are listed. Design parameters for the emergency core cooling system are presented. (D.C.C.)

6997 (DOCKET-50255-21) PALISADES PLANT. [Final Safety Analysis Report], Amendment 17. (Consumers Power Co., Jackson, Mich.). 14 Nov 1969. 107p. Dep. CFSTI.

Design requirements for the containment building end anchorage zone are described. Analysis of maximum hypothetical accident is presented. Actuation circuits for emergency power systems and emergency core cooling systems are illustrated. (D.C.C.)

6998 (DOCKET-50255-22) [PALISADES PLANT]. [Preliminary Safety Analysis Report], Amendment 18. (Consumers Power Co., Jackson, Mich.). 8 Dec 1969. 17p. Dep. CFSTI.

Design parameters and operation procedures for the iodine removal system are presented. Hydrogen venting systems for accident conditions are described. (D.C.C.)

6999 (DOCKET-50261-17) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2. Containment Design Report. (Westinghouse Electric Corp., [Pittsburgh, Pa. PWR Systems Div.] Ebasco Services, Inc., New York). Aug 1969. 288p. Dep. CFSTI.

For Carolina Power and Light Co., Raleigh, N. C.

Information relating to the containment structure is presented under the following headings: Summary; Containment Structural Design Basis; Containment Structure Elements; Containment Design and Comparison with Criteria; and Containment Fabrication and Erection. (D.C.C.)

7000 (DOCKET-50263-32) MONTICELLO NUCLEAR GENERATING PLANT, [UNIT 1]. Final Safety Analysis Report, Amendment 22. (Northern States Power Co., Minneapolis, Minn.). 31 Oct 1969. 63p. Dep. CFSTI.

Performance requirements of the emergency core cooling system are analyzed. Monitoring systems for accident conditions are described. Refueling accident fission product release rates are listed. Flood hazards for the reactor site are discussed. (D.C.C.)

7001 (DOCKET-50312-13) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Quality Assurance Program. (Sacramento Municipal Utility District, Calif.). 13 Nov 1969. 6p. Dep. CFSTI.

Responsibilities of the quality assurance organization are described. (D.C.C.)

7002 (DOCKET-50312-14) [RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1]. SMUD and Bechtel Quality Assurance Organizations. (Sacramento Municipal Utility District, Calif.). 20 Nov 1969. 3p. Dep. CFSTI.

Quality assurance organization charts are included. Charts represented both SMUD and Bechtel Quality Assurance Organizations. (D.C.C.)

7003 (DOCKET-50313-16) [ARKANSAS NUCLEAR ONE]. Preliminary Safety Analysis Report, Amendment 13. (Arkansas Power and Light Co., Little Rock). 31 Oct 1969. 173p. Dep. CFSTI.

Design requirements for containment structure anchorage zone are described. Stress analysis for the containment structure prestressing system is presented. (D.C.C.)

7004 (DOCKET-50321-13) EDWIN I. HATCH NUCLEAR PLANT, [UNIT 1]. Seismic Design Details for Drywell, Torus, and Personnel Lock. (Georgia Power Co., Atlanta). 1 Dec 1969. 6p. Dep. CFSTI.

7005 (DOCKET-50322-15) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 9. (Long Island Lighting Co., Mineola, N. Y.). 19 Nov 1969. 23p. Dep. CFSTI.

Materials and fabrication requirements for the emergency core coding system are described. General design parameters for emergency systems are included. (D.C.C.)

7006 (DOCKET-50322-16) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 10. (Long Island Lighting Co., Mineola, N. Y.). 5 Dec 1969. 41p. Dep. CFSTI.

Seismic stress analysis of reactor building is presented. Piping system stress analysis is included. Penetrations for the containment structures are listed. (D.C.C.)

7007 (DOCKET-50324-14) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Safety Evaluation. (Carolina Power and Light Co., Raleigh, N. C.). 31 Oct 1969. 138p. (DOCKET-50325-14). Dep. CFSTI.

The safety evaluation of the Brunswick Power Reactor, Units 1 and 2 by the USAEC, Division of Reactor Licensing is given. Findings of the safety anslysis pertain to: site, nuclear steam supply system, plant design, waste processing system, engineered safety features, accident analyses, development programs, technical qualifications, quality assurance, ACRS report, common defense and security, and conformance to general design criteria. Appendices include: computer ACRS reports and reports from Air Resources Environmental Laboratory, U. S. Geological Survey, U. S. Coast and Geodetic Survey, Fish and Wildlife Service and Naval Ordnance Laboratory. (M.L.S.)

7008 (DOCKET-50331-15) DUANE ARNOLD ENERGY CENTER. Preliminary Safety Analysis Report, Amendment 9. (Iowa Electric Light and Power Co., Cedar Rapids). 5 Nov 1969. 24p. Dep. CFSTI.

Environmental radiation monitoring systems are described. Instrument penetrations are discussed. Blowdown pressures for the primary containment pressure suppression system are analyzed. Design requirements for piping systems are described. (D.C.C.)

7009 (DOCKET-50335-9) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 4. (Florida Power and Light Co.). 31 Oct 1969. 86p. Dep. CFSTI.

Purging procedures and requirements for the containment system following a major hypothetical accident are analyzed. Purging equipment is described. Analysis of possible tornado hazards is presented. Requirements for foundation excavation and backfill are described. (D.C.C.)

7010 VACUUM CLEANING IN THE ENRICO FERMI REACTOR. Gunning, John E.; Matte III, Joseph; Ryan, J. Doyle (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 12: 860-1(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7011 FUEL MANAGEMENT AND OPERATION OF DRESDEN 1, CYCLE 6. Goldstein, L. (United Nuclear Corp., Elmsford, N. Y.); Butterfield, L. D. Trans. Amer. Nucl. Soc., 12: 440(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7012 PROCESS COMPUTER FOR BOILING WATER REACTORS. Jones, A. B.; Fuller, C. L. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 12: 787(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7013 NEW COOLANT CLEANUP SYSTEM FOR BWR NUCLEAR POWER STATIONS. Shiells, D. A. (Bechtel Corp., San Francisco). Trans. Amer. Nucl. Soc., 12: 779-80(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7014 NONLINEAR OPTIMIZATION CODE AND ITS USE IN NUCLEAR PRODUCTION AND DESIGN PROBLEMS. Cross, K. E. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 442-3(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7015 WHO NEEDS A NUCLEAR POWER REACTOR SAFETY COMMITTEE? Lanning, David D. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 792-3(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7016 SAFETY COMMITTEE EXPERIENCE AND EFFECTIVENESS. Nertney, R. J. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 12: 791-2(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7017 SAFETY COMMITTEE EXPERIENCE IN NUCLEAR POWER PLANT OPERATION. Minnick, L. E. (Yankee Atomic Electric Co., Boston). Trans. Amer. Nucl. Soc., 12: 790-1 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7018 ROLE OF OPERATIONS AND SAFETY COMMITTEES FOR NUCLEAR POWER PLANTS. Witzig, W. F.; Palladino, N. J. (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc., 12: 790(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7019 COMPUTERS AND IN-CORE INSTRUMENTATION. Keeley, G. S.; Walke, G. J. (Consumers Power Co., Jackson, Mich.). Trans. Amer. Nucl. Soc., 12: 788-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7020 ROLE OF A USER IN A COMPUTER APPLICATION. Rodgers, J. T.; Porter, D. E. (Florida Power Corp., St. Petersburg). Trans. Amer. Nucl. Soc., 12: 787-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7021 SAXTON OVERPOWER TEST. O'Neil, E. J.; Jordan, K. R.; Miller, R. S. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 551(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7022 UTILITY MANAGEMENT TRAINING. Wittke, Dayton D. (Univ. of Nebraska, Lincoln). Trans. Amer. Nucl. Soc., 12: 429-30(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7023 PROBABILISTIC ASSESSMENT OF SEISMIC RISK FOR NUCLEAR POWER PLANTS. Chalapati, C. V. (Holmes and Narver, Inc., Los Angeles); Wall, Ian B. Trans. Amer. Nucl. Soc., 12: 684(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7024 PHYSICS OF OPERATING BOILING WATER REACTORS. Fuller, Edward D. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 12: 643(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7025 PHYSICS OF OPERATING PRESSURIZED WATER REACTORS. McFarlane, A. F. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 643(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7026 PHYSICS PERFORMANCE OF SHIPPINGPORT CORE 2. Flanagan, C. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 643-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7027 EXPERIENCE WITH XENON OSCILLATIONS. Graves, W. E. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 12: 644-5(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7028 ON-LINE SYSTEM FOR REMOTE MONITORING OF POWER REACTOR OPERATIONS. Fisher, J. R.; Kendrick, E. D.; Eggens, C. J. (Nuclear Associates International Corp., Rockville, Md.). Trans. Amer. Nucl. Soc., 12: 785(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7029 ROLE OF COMPUTERS AND IN-CORE INSTRUMENTATION IN FUTURE SAFETY SYSTEMS. Stone, J. T.; Fitzgerald, D. G.; Rudy, G. C. (Nuclear Utility Services, Inc., Rockville, Md.). Trans. Amer. Nucl. Soc., 12: 785-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7030 IMPROVED METHODS FOR PLANNING OF THERMAL DISCHARGES BEFORE SITE ACQUISITION. Jaske, R. T. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 813-14(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7031 APPLICATION OF THE HALING PRINCIPLE TO REACTOR OPERATION. Fultz, C. A. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 12: 819(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7032 PHYSICS RESULTS FROM PEACH BOTTOM UNIT 1 OPERATIONS. Lane, Richard K.; Nowicki, Stanley J.; Brown, James R. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 819-20(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7033 METHOD OF ANALYZING IN-CORE DETECTOR DATA IN POWER REACTORS. Hellens, R. L. (Combustion Engineering Inc., Windsor, Conn.); Ober, T. G.; Ober, R. D. Trans. Amer. Nucl. Soc., 12: 820-1(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7034 NUCLEAR NOISE MEASUREMENTS ON REACTOR CORE VERTICAL MOTION. Rajagopal, V. (Westinghouse Electric Corp., Pittsburgh); Rawle, D.; Andognini, G. C. Trans. Amer. Nucl. Soc., 12: 821(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7035 INTERPRETATION OF POWER COEFFICIENTS MEASURED IN OPERATING REACTORS. Hellens, R. L.; Dechand, C. O.; Congdon, M. E. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 12: 914(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7036 PROBABILITY DISTRIBUTION OF INHALATION DOSE FOLLOWING A LOSS-OF-COOLANT ACCIDENT. Brunot, W. K. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 684-5(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7037 APPLICATION OF RISK ALLOCATION TO REACTOR SITING AND DESIGN. Otway, H. J.; Erdmann, R. C. (Univ. of California, Los Angeles). Trans. Amer. Nucl. Soc., 12: 686-7 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7038 PLANT DESIGN PARAMETERS AND TIME-VARYING FACTORS IN SITE SELECTION. Velez, Carlos (Instituto Politecnico Nacional, Mexico City). Trans. Amer. Nucl. Soc., 12: 687-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7039 SPATIAL XENON STABILITY MEASUREMENTS ON THE CONNECTICUT YANKEE REACTOR. Rawle, D. (Westinghouse Electric Corp., Cheswick, Pa.); Rajagopal, V.; Poncelet, Claude G.; Johnson, R. Joe; Himmelwright, J. R. Trans. Amer. Nucl. Soc., 12: 766-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7040 INDIAN POINT INSPECTIONS: EXPERIENCES ON UNIT NO. 1. PLANS FOR UNIT NO. 2. Prestele, Joseph A.; Makepeace, John M. (Consolidated Edison Company of New York, Inc., Buchanan). Trans. Amer. Nucl. Soc., 12: 775 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7041 IN-SERVICE INSPECTION: WHY AND HOW. Bailey, Eugene C. (Commonwealth Edison Co., Chicago). Trans. Amer. Nucl. Soc., 12: 775-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7042 IN-SERVICE INSPECTIONS OF THE ELK RIVER POWER REACTOR. Norris, E. B.; Whiting, A. R.; Wylie, R. D. (Southwest Research Inst., San Antonio). Trans. Amer. Nucl. Soc., 12: 776(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7043 FIRE PROTECTION FOR NUCLEAR PLANTS. Crose, Herschel C.; Hoffman, Roy C. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 778(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7044 ASPECT OF POPULATION DISTRIBUTION IN ASSESSING A NUCLEAR POWER PLANT SITE. Schwarzer, Wolfgang (Institut fuer Reaktorsicherheit, Cologne). Trans. Amer. Nucl. Soc., 12: 778-9(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7045 REACTOR SAFETY STANDARDS: A PROBLEM IN OPTIMIZATION OF SOCIAL COSTS. Weisman, Joel (Univ. of Cincinnati). Trans. Amer. Nucl. Soc., 12: 685-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7046 SHARP MANAGEMENT AT STARTUP CUTS NUCLEAR FUEL COSTS. Thompson, Orville K. Elec. Light Power (Boston); 69-75(Aug 1969).

Proper fuel management programs in nuclear power plants can result in substantial cost savings. The nuclear fuel bundle design, loading, shuffling, discharge, and plant factor and power density have significant effects on fuel cycle costs. The nature of in-core fuel management responsibilities is defined, and the economic effects of various program alternatives are discussed. (H.D.R.)

7047 GROSSWELZHEIM SUPERHEAT REACTOR: CONCEPT AND POSSIBILITIES. Kombichler, H. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech., 14: 531-3(Nov. 1969). (In German).

Several characteristics of the HDR are described. The core consists of tube-like elements that are cooled on the outside by boiling water. Steam is conducted through the interior and superheated. The concept represents an alternative to the U.S. development, which contains two core sections — one for steam production and the other for superheating. Difficulties encountered in fuel element production are discussed as are those encountered in the construction of the steam conducting system. In early trials fuel elements were deformed. Causes for the damage are analyzed and modifications explained. Economic advantages of the superheat versus the boiling water reactor are delineated. (H.B.G.)

7048 HDR: PROGRAM FOR STARTUP-TO-ON-LINE OPERATION. Kuehnel, R. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech., 14: 547-9(Nov. 1969). (In German).

Reported is a program to be performed on the HDR before on-line operation can be achieved. The first series of tests are performed at zero power while the fuel elements are inserted into the HDR core in a dry state. Then, the boiler side of the elements is flooded with water and, finally, the superheated side with steam. This testing phase is concluded with measurements of vibrations that might be caused hydrodynamically. After satisfactory conclusion of the previous phase the reactor power is raised by manual control to 3 MW under low pressure and at temperatures not exceeding 150°C. Numerous tests as to fuel elements, control rods, neutron flux, radioactive contamination, and measurements of pressure and temperature are outlined. All of the tests are repeated as reactor power is increased in 10 MW steps to its final power of 100 MW. Before on-line operation, tests of accidental disturbances will be performed. (H.B.G.)

7049 CONSTRUCTION OF THE HDR INSTALLATION. Doerler, R. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech., 14: 534-7(Nov. 1969). (In German).

Characteristics of the HDR are summarized. Considerations entering site selection are explained. Construction of the entire power plant is shown by cross sections both horizontal and vertical. The steam production and utilization are discussed. Supporting facilities for the reactor are discussed as to pumps for cooling water, purification of reactor water, installations for exchange of fuel elements and control rods, installations for handling radioactive effluents, electrotechnical equipment, and instrumentation for control and surveillance. (H.B.G.)

7050 PECULIARITIES WITH THE DEVELOPMENT AND COMPLETION OF THE HDR FUEL ELEMENTS. Hoechel, J. (AEG-Telefunken, Grosswelzheim, Ger.); Fricke, W. Atomwirt., Atomtech., 14: 549-55(Nov. 1969). (In German).

Design and testing of fuel elements of HDR are described. In principal, they represent a hollow tube of enriched uranium oxide. Enrichment values and inside and outside cladding materials are tabulated. Also tabulated are thermal flux, fuel element temperature, and steam temperature under various experimental conditions. Damage to fuel elements was analyzed as to cause and prevention. Prototype fuel elements were subjected to tests as to mechanical properties, emergency cooling, thermal-hydraulic efficiency, and ease of handling. Results are discussed. Production procedures for the final fuel elements are described in detail and displayed by flow diagrams as well as photographs. (H.B.G.)

7051 HDR PROJECT: GOALS AND PERFORMANCE. Eitz, A. W.; Mueller-Dietsche, W.; Tebbert, H. (Gesellschaft fuer Kernforschung mbH, Leopoldshafen, Ger.). Atomwirt., Atomtech., 14: 526-30(Nov. 1969). (In German).

Difficulties encountered during construction of the HDR and the necessary counter measures are described. Major problems arose during construction of the reactor pressure vessel, the desuperheater, pumps, and fuel elements. In October 1969 all problems were solved and the reactor went critical. Zero power examination was completed and corresponded to precalculations, which are summarized. Power tests are projected for early 1970. (H.B.G.)

7052 HDR: CONSTRUCTION AND CHARACTERISTICS. Traube, K.; Seyfferth, L. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech., 14: 539-46(Nov. 1969). (In German).

Characteristics of the HDR are described in detail. The reactor serves as prototype for later large scale power plants. The boiling water reactor principle is maintained. However, the fuel elements are modified to form loops through which the saturated steam can be conducted for superheating. Main characteristics are as follows: power, 100 MW(t); main fuel element temperature, 1750°C; steam pressure, 73 atm; and steam temperature, 457°C. Pictures and tables give detailed descriptions of the arrangement of fuel elements, steam conduction, and control mechanism. (H.B.G.)

7053 GRID HOOKUP FOR THE HDR. Schoenig, R.; Wirth, W. (Abteilungsleiter der Heissdampfreaktor Betriebsgesellschaft mbH, Grosswelzheim, Ger.). Atomwirt., Atomtech., 14: 555-6(Nov. 1969). (In German).

For control purposes, the HDR was subdivided into functional groups for which electrical control mechanisms could be easily developed. How these functional groups are integrated into a full automatic control system for the reactor is described. A diagram of the control panel is presented. (H.B.G.)

Power Reactor Development

Refer also to abstracts 5776–5778, 5780, 6234, and 6238.

7054 (CISE-R-118) PRELIMINARY ESTIMATE OF THE UNIT ENERGY COST OF FUEL AND HEAVY WATER FOR THE CIRENE REACTOR FUELED WITH URANIUM METAL. Technical Report No. 11. Astolfi, A. (Centro Informazioni Studi Esperienze, Milan (Italy)). July 1965. Contract 005.63.7-NTRI. 96p. (In Italian). Dep. CFSTI (U. S. Sales Only).

Methods for calculating the fuel and heavy water components of the unit energy cost for the metallic U fueled reactor of the CIRENE-1 program are presented. The fuel element is a natural U tube, clad on both sides with Zircaloy 2. The tube is cooled only from the inside and the inner cladding acts also as a pressure tube. The fabrication costs are estimated on the basis of a coextrusion process. These methods have been subsequently applied to one of the core configurations studied in the CIRENE-1 program. The resulting partial costs are only indicative because some uncertainties affect the numerical values assumed for the parameters involved in the calculations. (auth)

7055 CONCEPTUAL DESIGN OF A 350-MW(e) DEMONSTRATION FAST BREEDER REACTOR. Duffy, J. G. (Atomic Power Development Associates, Inc., Detroit); Lagowski, J. P.; Odajima, K.; Sasaki, S. Trans. Amer. Nucl. Soc., 12: 768(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7056 MIDLAND DUAL-PURPOSE NUCLEAR PLANT. Kessler, W. E.; DeWitt, R. B. (Consumers Power Co., Jackson, Mich.). Trans. Amer. Nucl. Soc., 12: 781-2(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7057 EVALUATION OF ACCELERATOR RADIATION EXPERIMENTS FOR REACTOR DAMAGE PROBLEMS. King, R. T.

(Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 699-700(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7058 INVESTIGATION OF CRITICAL FLOW CONDITION DURING A LOSS-OF-COOLANT ACCIDENT. Curet, H. D. (Idaho Nuclear Corp., Idaho Falls); Shiba, M. Trans. Amer. Nucl. Soc., 12: 879-80(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7059 FAST REACTOR DEVELOPMENT AND NUCLEAR ENGINEERING ACADEMIC PROGRAMS: A NEW COMPREHENSIVE COURSE IN FAST REACTORS. Malaviya, B. K. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 12: 427-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7060 UNIVERSITY-INDUSTRY COOPERATIVE TEACHING LABORATORY IN NUCLEAR ENGINEERING. Long, R. L. (Univ. of New Mexico, Albuquerque); Jefferson, R. M. Trans. Amer. Nucl. Soc., 12: 425(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7061 FEDERAL SUPPORT OF ACADEMIC RESEARCH: A GROWTH ISSUE? Herwig, Lloyd O. (National Science Foundation, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 432-3 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7062 CONTINUING EDUCATION IN NUCLEAR ENGINEERING: PROGRESS AND PROBLEMS. Hang, Daniel F. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 12: 435-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7063 PROFESSIONAL INTERNSHIPS IN ENGINEERING. Carter, Robert L. (Univ. of Missouri, Columbia). Trans. Amer. Nucl. Soc., 12: 435(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7064 PRACTICE SCHOOL: BRIDGE FOR THE ACADEMIC/INDUSTRIAL GAP. Mason, E. A.; Fleming, S. M. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 435(Nov. 1969).
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7072 ON THE PROBLEM OF OPTIMIZING LONG RANGE REACTOR PLANNING. II. POSSIBILITIES AND LIMITS OF MODEL CALCULATIONS. Finnemann, H.; Maerkl, H. Atomwirt., Atomtech., 14: 416-18(Aug. 1969). (In German).
Calculations were performed for model reactors. Since some of the parameters are uncertain, the following conclusions demand a certain degree of caution. The development of fast breeder reactors with small breeder potential hold little promise for the future. Economically, high breeder potential is far superior even if longer time spans for development are required. If high efficiency breeder reactors are available by 1985 or 1990, present day plutonium should be stored instead of being used in thermal converters. If uranium costs and fuel element reprocessing costs increase appreciably above present day values, natural uranium reactors will remain economical to the end of the century. Light water reactors will prevail for a long time because of their suitability in the middle range of power production. Experience with high temperature reactors is too sporadic to allow projections. If the cost of nuclear power plants does not decrease significantly, conventional fossil fuel installations will prevail far beyond the year 2000. (H.B.G.)

Kinetics and Dynamics

7073 ANALYTICAL ESTIMATE OF DOPPLER-CONTROLLED ENERGY RELEASE IN A FAST REACTOR DISASSEMBLY TRANSIENT. Lee, John C.; Pigford, Thomas H. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 12: 918-19(Nov. 1969).
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7077 COOLANT VOID REACTIVITY EFFECTS IN HEAVY-WATER-MODERATED URANIUM SYSTEMS. Thompson, T. J.; Papay, L. T. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 666(Nov. 1969).
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Gelbard, E. M.; Steen, N. M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 626-7(Nov. 1969).
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7082 NEUTRON ENERGY SPECTRA FOR FAST REACTOR IRRADIATION EFFECTS. Okrent, D. (Argonne National Lab., Ill.); Kallfelz, J. M.; Loewenstein, W. B.; Rossin, A. D.; Smith, A. B.; Zolotar, B. A. Trans. Amer. Nucl. Soc., 12: 701(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7083 APPLICATIONS OF NUCLEAR ENERGY FOR HUMANITIES STUDENTS. Long, Robert L. (Univ. of New Mexico, Albuquerque). Trans. Amer. Nucl. Soc., 12: 433-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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7090 ANALYSIS OF RECENT DOSIMETRY EXPERIMENTS IN EBR-II. Madell, J. T.; Dudey, N. D.; Heinrich, R. R.; Jarka, R. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 939-40(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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7095 MULTIDIMENSIONAL EFFECTS IN THE ANALYSIS OF XENON SPATIAL STABILITY. Lee, R. R. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 12: 760-1(Nov. 1969).
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7096 FREQUENCY RESPONSE TESTING TECHNIQUES USED ON MSRE. Steffy, R. C. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 740-1(Nov. 1969).
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7097 ASYMMETRY AND LOCAL DISTORTIONS OF THE FLUX DUE TO GROSS HETEROGENEITIES IN EBR-II. Miller, L. B.; Jarka, R. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 772(Nov. 1969).
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7098 SOME PHYSICS ASPECTS IN THE DESIGN OF A CARBIDE-FUELED FAST BREEDER. Lill, G.; Born, F.; Eckey, H.; Hauser, W.; Killian, P.; Knuth, M.; Reinke, P. (AEG-Telefunken, Grosswelzheim, Ger.). Trans. Amer. Nucl. Soc., 12: 772-3(Nov. 1969).
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Control Systems

7099 THREE-DIMENSIONAL DYNAMIC BEHAVIORS OF A REACTOR ZONAL CONTROL. Shinoda, W.; Mitake, S. (Japan Atomic Energy Research Inst., Tokai). Trans. Amer. Nucl. Soc., 12: 761-2(Nov. 1969).
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Cooling Systems

Refer also to abstracts 5804 and 5955.

7100 (STI/DOC-10/99) GUIDE TO THE PERIODIC INSPECTION OF NUCLEAR REACTOR STEEL PRESSURE VESSELS. Report of a Meeting Held in Stockholm, Sweden, 21-25 October 1968. Technical Reports Series No. 99. (International Atomic Energy Agency, Vienna (Austria)). 1969. 69p. Dep. IAEA $3.00.

General information is presented for reactor owners or operators, inspection authorities, certifying authorities or regulatory bodies who are responsible for establishing inspection procedures for specific reactors or reactor types, and for the preparation of national codes or standards. The recommendations apply primarily to water-cooled steel reactor pressure vessels but are also applicable to other reactor types. A general discussion is presented of factors, conditions, and potential failure mechanisms. Brief descriptions of inspection techniques are included. (auth)

7101 INCIPIENT BOILING CONDITIONS IN A BLOCKED LMFBR SUBASSEMBLY. Holtz, Robert E.; Singer, Ralph M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 912-13(Nov. 1969).
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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7103 PIPE RUPTURE CONSIDERATIONS OF THE SODIUM-COOLED GPU/NR-FBR. Drucker, Gilbert S. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 823-24(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7104 HYDRAULIC IMPEDANCE: A TOOL FOR PREDICTING BOILING LOOP STABILITY. Anderson, T. T. (Argonne

National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 833-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7105 SODIUM BUBBLE COLLAPSE AND PRESSURE GENERATION. Theofanous, T. G. (Argonne National Lab., Ill.); Isbin, H. S.; Fauske, H. K. Trans. Amer. Nucl. Soc., 12: 909-11(Nov. 1969).
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7106 VAPORIZATION AND EXPULSION MEASUREMENTS WITH SUPERHEATED SODIUM. Singer, Ralph M.; Holtz, Robert E.; Niemoth, Hubert R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 911(Nov. 1969).
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7107 HEAT REMOVAL FROM A 350-MW(e) DFBR. Ford, J. A. (Atomic Power Development Associates, Inc., Detroit); Kanamori, A.; Meshii, T. Trans. Amer. Nucl. Soc., 12: 768-9 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7108 EFFECTS OF REACTOR SYSTEM DESIGN ON SODIUM VOIDING ACCIDENTS. Meinhardt, W. G.; Bender, D. J.; Magee, P. M. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 908(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7109 SUPERHEAT EXPULSION IN SINGLE AND MULTIPIN CHANNELS: SIMULATION OF BLOCKED SUBASSEMBLY VOIDING. Grolmes, M. A.; Fauske, H. K.; Lambert, G. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 907-8(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7110 SENSITIVITY OF ENERGY RELEASE IN HYPOTHETICAL FAST REACTOR FLOW BLOCKAGE ACCIDENTS TO COOLANT VOIDING DYNAMICS. Freeman, D. D. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 906-7 (Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7111 EFFECT OF NONCOHERENCE IN FAST REACTOR SODIUM VOIDING ACCIDENTS. Stevenson, M. G.; Scott, J. H.; Hostetler, D. R. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc., 12: 905-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7112 PASET: A TRANSIENT CODE FOR PLANT ANALYSIS OF SODIUM VOIDING. Tilbrook, R. W.; Macrae, G. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 904-5(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7113 COMPRESSIBLE MODEL FOR TRANSIENT SODIUM BOILING. Siegmann, Eric R. (Northwestern Univ., Evanston, Ill.). Trans. Amer. Nucl. Soc., 12: 904(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7114 IMPROVEMENTS IN VAPOUR GENERATING AND SUPER-HEATING UNIT. Charcharos, Anthreas Nicholas (to Babcock and Wilcox Ltd., London). British Patent 1,167,723. 22 Oct 1969. Filed 20 Oct 1965.

Reference is made to vapor generating apparatus in which the heat is supplied by a liquid alkali metal, such as the Na of a liquid cooled nuclear reactor. In such reactors if a fault leading to a water-sodium reaction should occur the consequences could develop into a serious hazard. The object of the system described is to provide vapor generating and superheating apparatus by means of which a high degree of reliability may be achieved. Two heat exchangers are connected for series flow of plant operating fluid and for series flow of the liquid alkali metal in the opposite sense. Each heat exchanger comprises an upright vessel having an opening at its upper end, with suitable closure means, and means of admitting alkali metal to, and removal from, the vessel at locations below the closure. A number of parallel-connected tubes are provided within the vessel to provide a flow path for the operating fluid; these tubes are welded to the closure means but not to any other part of the vessel, being unjointed between the welding points, and being arranged so that the major part of the length of each is an upriser tube, the level of the liquid alkali metal in each of the vessels being below the welds. The upriser tube may be in spiral form and connected to a straight downcomer tube. An annular space may be provided in the vessel by use of a baffle, the upriser tubes lying within the baffle and the downcomer tubes lying within the annular space. A blanket of inert gas may be provided within each vessel, between the surface of the liquid alkali metal and the closure means. The heat exchangers may form part of a once-through forced-flow vapor generating and superheating unit, the transition zone being confined to the first of the heat exchangers relative to the flow of operating fluid. (UK)

Fuels

Refer also to abstracts 5589 and 5687.

7115 (ANL–7560) FAULT PROPAGATION IN AN EBR-II MARK-II DRIVER-FUEL SUBASSEMBLY. Campise, A. V. (Argonne National Lab., Ill.). Mar 1969. Contract W-31-109-eng-38. 69p. Dep. CFSTI.

The consequences of cladding failures in a Mark-II EBR-II experimental fuel element were evaluated under steady-state power. The principal consequences considered were the blanketing of adjacent fuel elements in a fuel subassembly with fission gas and the interactions of Na and molten fuel following a partial loss of Na bond in a fuel element. The possibility of fault propagation was evaluated based on physical properties of the Mark-II driver-fuel subassembly and the EBR-II reactor core. The results indicate an extremely low probability for propagation of faults in fuel elements due to gas blanketing or rapid formation of Na vapor resulting from interaction of Na and molten fuel. Upper-limit conditions for fault propagation are shown to be restricted to an area of thermohydrodynamic combined-system values that indicate an extremely low probability of occurrence. 17 references. (auth)

7116 (UNC–5229) FAST REACTOR MIXED CARBIDE FUEL ELEMENT DEVELOPMENT. COMPATIBILITY OF SEVERAL CLADDING MATERIALS WITH URANIUM–PLUTONIUM CARBIDES IN SODIUM. Powers, R.; Strasser, A. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Nov 1968. Contract AT(30-1)-3415. 66p. Dep. CFSTI.

The compatibility of plutonium–uranium carbide fuels with Type 304 and Type 316 stainless steel and with Incoloy-800 was tested in the presence of Na at 800°C for 1000 and 4000 hr. No carburization of these clads or decarburization of fuel was detected metallographically for MC containing 10 v/o M_2C_3 or for single-phase MC ($M = U_{0.80}Pu_{0.20}$). All fuels were prepared by reaction of the oxides with carbon followed by cold pressing and sintering to minimum densities of 94% of theoretical. The principal fuel tested, MC + 10 v/o M_2C_3, had an equivalent carbon content of 5.08 wt %, a carbon content of 4.74 wt %, and 0.1 wt % nickel sintering aid. Single-phase MC, with no sintering aid, had an equivalent carbon content of 4.70 wt % and a carbon content of 4.57 wt %. Single-phase M_2C_3 ($M = U_{0.85}Pu_{0.15}$) with a 6.95 wt % equivalent carbon and 6.89 wt % carbon content, however, carburized Type 304 to a depth of 0.010 in. in 1000 hr and 0.020 in. in 4000 hr. The fuel showed surface attack. Of the diffusion barriers tested, tungsten, chromized Type 316, zirconium foil-lined Type 316, carburized tantalum, and carburized niobium, none was carburized in sodium by MC + 10 v/o M_2C_3 after 4000 hr at 800°C. 36 references. (auth)

7117 DETERMINATION OF BURNUP IN EBR-II. Ebersole, E. R.; Kirn, F. S. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 690(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7118 HYBRID SOLUTION OF ENERGY EQUATIONS IN POROUS FUEL. Marr, W. W. (Argonne National Lab., Ill.); El-Wakil, M. M. Trans. Amer. Nucl. Soc., 12: 623-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7119 INTERNALLY PRESSURIZED ZIRCALOY-CLAD FUEL RODS. Ferrari, Harry M. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 554(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7120 ZIRCALOY-SHEATHED UO_2 GRAPHITE MATRIX FUELS IRRADIATED IN PRESSURIZED WATER. MacDonald,

R. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 12: 553(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7121 ANALYSIS OF MIXED-OXIDE FUEL PIN PERFORMANCE USING THE FMODEL COMPUTER CODE. Cox, C. M.; Homan, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 536-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7122 PREDICTION SYSTEM FOR FAST REACTOR FUEL PIN DEFORMATIONS. Merckx, K. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 535-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7123 FISSION YIELD OF XENON AND KRYPTON ISOTOPES IN $(PuU)O_2$ FAST REACTOR FUEL. Nelson, R. C. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 562-4(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7124 DEFECTIVE FUEL PIN TESTING IN FORCED-CONVECTION CAPSULES. Novak, P. E. (General Electric Co., Sunnyvale, Calif.); Pfefferlen, H. C.; Murata, R. E.; Tunnell, G. W. Trans. Amer. Nucl. Soc., 12: 799-800(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7125 IRRADIATION EXPERIMENTS ON FUEL ELEMENTS FOR A STEAM-COOLED FAST REACTOR. Antoni, R.; Hoechel, J.; Plitz, H. (AEG-Telefunken, Grosswelzheim, Ger.). Trans. Amer. Nucl. Soc., 12: 606-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7126 MELTING HEAT RATING OF UO_2–25 WT. PERCENT PuO_2 FUELS. Lawrence, L. A.; Christensen, J. A.; Horn, G. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 562(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7127 ECONOMIC POTENTIAL OF HIGH PERFORMANCE (U,Pu) CARBIDE IN AN LMFBR. Storrs, C. L.; Menzel, G. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 12: 577(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7128 EFFECT OF VARIABLE FUEL DENSITY IN A DISASSEMBLY TRANSIENT. Lee, John C.; Pigford, Thomas H. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 12: 919-20(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7129 PRODUCING ADVANCED FUELS FOR LMFBR'S Leitnaker, J. M.; Lindemer, T. B.; Spear, K. E.; Notz, K. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 579-80(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7131 SPECTRAL EFFECTS ON CALCULATED FUEL-CYCLE PARAMETERS IN LARGE FAST BREEDERS. Alcouffe, Raymond E.; Hirons, Thomas J.; O'Dell, R. Douglas (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 695-6(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7132 EVALUATION OF THE CRITICALITY PROBLEM IN IRRADIATED FUEL SHIPMENT. Rollins, J. D.; Ridihalgh, J. L. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 892-3(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7133 CORE CLAMPING SYSTEM DESIGN FOR FAST REACTORS. Waymire, G. R.; Mohr, C. L. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 797(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7134 FAST REACTOR FUEL PERFORMANCE MODEL DEVELOPMENT. Boltax, A.; Murray, P.; Baincheria, A. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 537(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7135 DEPENDENCE OF FAST REACTOR START-UPS ON THE THORIUM FUEL CYCLE. Lang, L. W. (Douglas United Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 443-4(Nov. 1969).
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Operation and Economics

7138 REPLICATION IN LIQUID SODIUM USING SILICONE RUBBER. Paxson, E.; Grundy, B. R. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 822-3 (Nov. 1969).
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7139 INSPECTION AND MAINTENANCE CONSIDERATIONS FOR A 350-MW(e) DFBR. Lagowski, J. P. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 12: 669-70(Nov. 1969).
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Safety and Siting

Refer also to abstract 7308.

7141 (BMI-1871) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, July-September 1969. Carbiener, Wayne A.; Ritzman, Robert L. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1969. Contract W-7405-eng-92. 40p. Dep. CFSTI.

REACTOR FUEL ELEMENTS—cladding of boiling and pressurized water, effects of coolant loss on swelling of
REACTOR SAFETY—coolant loss accidents in boiling and pressurized water reactors, analytical description of
REACTORS, BOILING—coolant loss accidents in, evaluation of data for analytical description of
—kinetics equations for, modifications in ADEP-1 and ADEP-2 computer programs for one and two dimensional
—fuel element cladding for, effects of coolant loss on swelling of
—emergency core cooling system performance during coolant loss accidents, thermal hydraulic computer programs for analysis of
REACTORS, PRESSURIZED-WATER—coolant loss accidents in, evaluation of data for analytical description of

—kinetics equations for, modifications in ADEP-1 and ADEP-2 computer programs for one and two dimensional
—fuel element cladding for, effects of coolant loss on swelling of
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7142 (DOCKET-50231-38) [SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR]. Malfunction of the Accumulator Leak Detection System on Control Drive No. 3. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). 18 Nov 1969. 2p. Dep. CFSTI.

Failure of the oil leak detection system for the accumulator on one of the 10 reflector segment control drives is analyzed. Effects of the detection system failure and possible oil leakage accumulation on scram response are described. (D.C.C.)

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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Power Conversion Systems

7164 FBR MODULAR STEAM GENERATOR DESIGN. Randall, I. E.; McDonald, J. S. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 770-12(Nov. 1969).
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7165 PERFORMANCE OF THE EBR-II STEAM GENERATORS AND INTERMEDIATE HEAT EXCHANGER. Koenig, J. F. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 773-4(Nov. 1969).

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Research and Test Reactors

Refer also to abstracts 5726, 5727, 5848, 5940, 6039, 6184, 6224, 7253, 7315, and 7353.

7166 (BNWL-1174) FAST FLUX TEST FACILITY. Quarterly Technical Report, June-August 1969. Astley, E. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1969. Contract AT(45-1)-1830. 170p. Dep. CFSTI.

BORON CARBIDES—radiation effects on vibrocompacted powders of
FAST FLUX TEST FACILITY—design and development during July to August 1969
FAST TEST REACTOR—design and development during July to August 1969
—core concept for, design data summary for vertical
—coolant for, materials evaluation for receiving and processing system for sodium
—cooling system for, design parameters for primary
—instrumentation development for
—coolant for, fission product behavior and control in sodium
—coolant for, sampling and analysis of sodium
—fuel burnup in, effect of stainless steel swelling on
—fuel subassemblies for, heat transfer and flow tests on
—cooling system piping for, remote welding of
—fuel element cladding for, radiation effects on stainless steel
—fuels for, irradiation testing of
—fuels for, processing and fabrication of
—physics analyses of
—safety analysis of
HEAT TRANSFER SYSTEMS—design parameters of FFTF primary
REACTOR FUEL ELEMENTS—radiation testing of FFTF
—radiation effects on EBR-2 driver pins
REACTOR FUELS—development of FTR mixed oxide, during July to August 1969
REACTOR SAFETY—accident analyses for FFTF
STAINLESS STEEL—radiation effects on fuel element cladding of Type 304 and Type 316, for FFTF (H.D.R.)

7167 (BNWL-1208) EVALUATION OF A TIME OF FLIGHT (TOF) MASS SPECTROMETER FOR ANALYSIS OF SODIUM COVER GAS. Barton, G. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

A Bendix Corporation Model MA-1 time of flight mass spectrometer was tested for possible use in the FFTF. The limiting sensitivity of the mass spectrometer was found to be adequate for FFTF Na cover gas analyses. Advantages and disadvantages are discussed. 2 references. (D.C.C.)

7168 (BNWL-1240) REACTOR PHYSICS QUARTERLY REPORT, JULY-SEPTEMBER 1969. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 128p. Dep. CFSTI.

CRITICALITY STUDIES—measurement of Plutonium Recycle Test Reactor Test 4
—calculation of water moderated plutonium oxide (PuO_2)-uranium oxide (UO_2) assemblies
—calculation of uranyl nitrate reflector savings for low enriched sphere arranged uranium rods
FAST TEST REACTOR—fuel elements of, effects of swelling behavior on design parameters for
NEUTRONS—multiplication factors in Physical Constants Testing Reactor, poisoned and unpoisoned techniques for measurement of
NEUTRONS, FAST—spectra in Fast Neutron Cavity of Physical Constants Testing Reactor
NEUTRONS, INTERMEDIATE—spectra in Fast Neutron Cavity of Physical Constants Testing Reactor
PHYSICAL CONSTANTS TESTING REACTOR—neutron multiplication factors in, poisoned and unpoisoned techniques for measurement of
—neutron spectra in Fast Neutron Cavity
PLUTONIUM RECYCLE TEST REACTOR criticality of, measurements for Test 4
REACTOR FUEL ELEMENTS—burnup in, modifications in BUFIT computer program for
—design parameters of Fast Test Reactor, effects of swelling behavior on
REACTOR SAFETY—core behavior for accident conditions in fast reactors
REACTORS—physics studies on, digital computer programs for
REACTORS, FAST—physics studies on, summary of July to September 1969
—neutron fast fission in, calculation of heterogeneity correction for
—core behavior in, effects of accident conditions on
REACTORS, THERMAL—physics studies on, summary of July to September 1969
—criticality of, comparison of diffusion and transport theory calculations for (D.C.C.)

7169 (CEA-R-3887) THEORETICAL AND EXPERIMENTAL STUDY OF A FAST SUBCRITICAL ASSEMBLY BY MEANS OF A NEUTRON SOURCE. Moret-Bailly, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sep 1969. 50p. (In French). Dep. CFSTI (U. S. Sales Only).

The Franco-German experiment EURECA-SUAK is briefly described. It has been studied for multiplication coefficients between 0.45 and 0.95. The decay curves are not pure exponentials. The decay calculations are made taking the geometrical effects and energy harmonics into account. The agreement between experimental and calculated curves is very good. The flux evaluation as a function of time is shown in several curves. (auth)

7170 (CISE-R-165) SUBCRITICAL ASSEMBLY TOPLESS: DESCRIPTION OF THE EXPERIMENTAL INSTALLATION AND PRELIMINARY ACTIVITIES REPORT. Topical Report No. 10. Accinni, F.; Ciuffolotti, L.; Guandalini, S.; Palazzi, F.; Parmeggiani, A.; Pirovano, B. (Centro Informazioni Studi Esperienze, Milan (Italy)). Sept 1965. 76p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The heavy water moderated TOPLESS critical assembly and auxiliary systems are described. Neutron current measurements in the core and thermal column are discussed; neutron flux calculations and measurements are detailed. The instrumentation for the critical assembly is described. All data are shown graphically. (M.L.S.)

7171 (ORNL-TM-2790) BULK SHIELDING FACILITY QUARTERLY REPORT, JULY-SEPTEMBER 1969. Tabor, W. H.; Hurt III, S. S.; Nixon, T. B. (Oak Ridge National Lab., Tenn.). 20 Nov 1969. 33p. Dep. CFSTI.

Operation and maintenance requirements during July to September 1969 are described. Descriptions of shutdowns during the quarter are presented. (D.C.C.)

7172 EQUIPMENT USED FOR EXAMINING, DISMANTLING, AND REASSEMBLY OF A HFIR FUEL ELEMENT. Parsley, W. B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 861(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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7175 ANALYSIS OF FUEL MELTDOWN STUDIES WITH TREAT. Agrawal, Askhok K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 865-6(Nov. 1969).

From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7176 FIRST TREAT LOOP EXPERIMENT ON OXIDE FUEL MELTDOWN. Dickerman, C. E. (Argonne National Lab., Ill.); Robinson, L. E.; Agrawal, A. K.; Boland, J. F. Trans. Amer. Nucl. Soc., 12: 867-8(Nov. 1969).

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7177 TRANSIENT BEHAVIOR OF PRE-IRRADIATED HIGH-SWELLING EBR-II DRIVER FUEL IN TREAT. Rothman, A. B.; Renken, C. J.; Stewart, R. R.; Dewey, G. G.; Hutchinson, D. R.; Dickerman, C. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 867(Nov. 1969).
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7178 PERFORMANCE OF STAINLESS-STEEL-CLAD, MIXED-OXIDE FUEL PINS. Weber, J. W.; Pember, L. A.; Leggett, R. D. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 604-5(Nov. 1969).
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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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7182 DETERMINATION OF THE COMPRESSIVE PROPERTIES OF IRRADIATED NUCLEAR FUEL PLATES. Hayner, G. O.; Dittmer, J. O.; Phipps, R. D. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 559-60(Nov. 1969).
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7183 EFFECTS OF BURNUP ON THE REACTIVITY ACCIDENT: TESTS OF FUEL RODS WITH LOW BURNUP. Miller, R. W. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 12: 862-3(Nov. 1969).
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7191 CRITICALITY OF PuO_2–UO_2 AQUEOUS MIXTURES. Hansen, L. E.; Bierman, S. R.; Lloyd, R. C.; Clayton, E. D. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 869-70(Nov. 1969).
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7193 EFFECTS OF INTERSPERSED WATER MODERATION ON SUBCRITICAL ARRAYS OF 3.5 WT. PERCENT PELLET CONTAINERS. Kropp, R. E. (United Nuclear Corp., New Haven); Lemberg, P.; Tomonto, J. R. Trans. Amer. Nucl. Soc., 12: 891-2(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7194 CRITICALITY OF TRANSURANIUM ACTINIDES: UNDERMODERATED SYSTEMS. Bierman, S. R.; Clayton, E. D. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 887-8(Nov. 1969).
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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7198 CRITICAL PARAMETERS FOR 0 TO 7 PERCENT PuO_2–U(Nat)O_2 RODS IN WATER. Brown, C. L.; Oden, D. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 873-5(Nov. 1969).
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7199 CRITICALITY OF $Pu(NO_3)_4$ SOLUTION SLABS HAVING HIGH ^{240}Pu CONTENT. Lloyd, R. C.; Clayton, E. D.; Hansen, L. E. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 870-2(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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Rocket and Space Reactors

Refer also to abstract 6582.

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Process Heat and Desalination Reactors

Refer also to abstract 7056.

Marine and Portable Power Reactors

7261 (DOCKET-50238-61) N.S. SAVANNAH. Emergency Core Cooling System. Revised Design Report. (Todd Shipyards Corp., Galveston, Tex.). 3 Nov 1969. 95p. Dep. CFSTI.
For First Atomic Ship Transport, Inc., New York.

7262 N. S. SAVANNAH: PRIMARY-SYSTEM INSPECTION DURING INITIAL REFUELING. Tillou, Joseph H. (Atomic Energy Commission, Washington, D. C.); Parker, Clarence W.; Thorpe, John R. Trans. Amer. Nucl. Soc., 12: 776-7(Nov. 1969).
From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

7263 WHY NO BRITISH NUCLEAR MERCHANTMAN? Livesey, R. Engineering; 208: 536-7(Nov 1969).

It is suggested that, with the development of the container ship and the supertanker, it is now essential for Britain to invest in the nuclear merchant ship. UKAEA studies on the burnable poison pressurized water reactor are briefly outlined. (UK)

7264 FILTRATION IN NAVAL NUCLEAR PROPULSION. Argiero, Luigi (Inst. Impianti Nuclear, Pisa, Italy). Tec. Ital.; 34: No. 1-3, 23-31(1969). (In Italian).

An important problem of nuclear ship propulsion is the limitation of injury to personnel, even in the maximum credible accident which could release radioactive Ca, Cs, I, and Te. The most suitable method for dealing with these radionuclides is to use high efficiency filters which are made of fibers or membranes. Particles can be separated by diffusion, gravity, or electrostatic precipitation. Various filter systems use aerosols of NaCl, dioctyl phthalate, paraffin oil, or the Na salt of fluorescein. (Selenium-Tellurium Abstr.)

Production Reactors

Refer also to abstract 7268.

7265 XENON OSCILLATION EXPERIMENTS IN A PRODUCTION REACTOR. Topp, S. V.; Germann, R. P. (E. I. duPont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 12: 765-6(Nov. 1969).
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Reactor Theory

Kinetics

Refer also to abstracts 6885, 7073, 7080, 7111, 7128, 7168, 7202, and 7212.

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7270 NUMERICAL STUDIES OF AN INITIAL-VALUE NEUTRON TRANSPORT PROBLEM. DeMuth, N. S. Jr.; Hendry, W. L. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 729-30(Nov. 1969).
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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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From 17th Conference on Remote Systems Technology, San Francisco, Calif. See CONF-691102.

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Dynamics

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7353 (BNWL-1224) PLUTONIUM UTILIZATION PROGRAM TECHNICAL ACTIVITIES QUARTERLY REPORT, JUNE–AUGUST 1969. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 78p. Dep. CFSTI.
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PLUTONIUM RECYCLE TEST REACTOR—operation during June to August 1969
—criticality of, measurements for Test 4
—fuel element assemblies of, radiation testing of plutonium oxide (PuO_2)–uranium oxide (UO_2) rod type
REACTIVITY—calculation of leakage effects on bare and reflected spheres
REACTOR FUEL ELEMENTS—burnup in, modifications in BUFIT computer program for
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7375 MATERIALS PROBLEMS IN NUCLEAR TECHNOLOGY. Moser, J. B. Int. J. Non-Destruct. Test.; 1: 91-107(Jun 1969).
Comparisons between thermal and fast materials applications are made. Properties of the LMFBR cladding and fuel materials are summarized. By comparing LWR and LMFBR operating and materials parameters, technological difficulties in advancing to the next generation of nuclear power reactors have become clearer. The significance of selected physical properties of fuel and cladding materials for the safety, lifetime, and power density of the core was evaluated. Recent property measurements of potential LMFBR fuel materials are given. (J.C.W.)

7376 NUCLEAR REACTOR AND CONTROL ROD THEREFOR. Anthony, Andrew J. (to Combustion Engineering, Inc.). U. S. Patent 3,480,510. 25 Nov 1969. Filed 4 Aug 1966.
A nuclear reactor and a flexible control rod are described, wherein less tolerance is required for the control rod opening between adjacent fuel assemblies. The control rod comprises a plurality of independent rectangular blades located in different planes and rigidly connected at the driven end. Each blade is in spaced relation with the other blades of the control rod throughout substantially its entire remaining length, providing flexibility of each blade in one plane. (Offic. Gaz.)

GENERAL

7377 (DP-1211) DERIVATIVE COMPUTER FOR THERMOGRAVIMETRIC ANALYSIS. Byrd, Joseph S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec 1969. Contract AT(07-2)-1. 7p. Dep. CFSTI.

A derivative computer was designed for use with an Ainsworth thermogravimetric analysis system. The basic circuit, a simple differentiator using an operational amplifier, is very stable and accurate. (auth)

7378 (EGG-1183-1446) CARE AND FEEDING OF FAST FOURIER TRANSFORM. Tech Report L-951. Ritenour, Robert (EG and G, Inc., Las Vegas, Nev.). 4 Aug 1969. 70p. Dep. CFSTI.

7379 (IN-1330) ANALYSIS OF FAULT TREES BY KINETIC TREE THEORY. Vesely, W. E. (Idaho Nuclear Corp., Idaho Falls). Oct. 1969. Contract AT(10-1)-1230. 94p. Dep. CFSTI.

7380 (LA-4199-TR) DETONATION OF COARSE-GRAINED EXPLOSIVES. Parfenov, A. K.; Voskoboinikov, I. M.; Apin, A. Ya. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Vzryvnoe Delo, Nauch.-Tekh. Gorn. Obshchest., Sb., No. 63/20, 60-5(1967). 5p. Dep. CFSTI.

Trinitrotoluene, RDX, and their 50/50 mixture were investigated at grain densities of 1.58, 1.70, and 1.68 g/cm^3, respectively. The detonation velocity, D, increased with increasing grain size. Changing the grain size from 2 to 10 mm increased D by 700 m/sec for TNT, and by 800 to 900 m/sec for RDX and the 50/50 mixture. For 10-mm grains, D was only 150 to 200 m/sec less than the maximum possible with the given grain density. The grain size permitting near maximum D was expected to be proportional to the critical charge diameter, but experiment disproved this assumption. Maximum D for all explosives was reached at 10-mm grain size, while the critical charge diameter was 2 mm for TNT, 0.5 mm for RDX, and 3 mm for their 50/50 mixture. (auth)

7381 (LA-4205) THE TACS1 PROGRAM. Wilson, Charles L.; Brient, S. John; Cornwell, Fred L. (Los Alamos Scientific Lab., N. Mex.). 27 Jun 1969. Contract W-7405-eng-36. 350p. Dep. CFSTI.

The TACS1 (Transport and Charge Storage) program is a general-purpose program designed to calculate electrical charge transport and charge storage effects in one-dimensional semiconductor structures of silicon and germanium. Electrostatic potentials and hole and electron distributions are calculated as functions of distance; certain integral parameters such as currents, voltage sensitivity of stored charge, and recombination-generation effects are also calculated. The program uses Fermi-Dirac statistics throughout; the physical effects of impurity scattering and of electric fields on mobilities are also included. Recombination-generation effects include recombination through a monovalent Shockley-Read center, secondary ionization (avalanche), and Zener tunneling. The program is written in FORTRAN IV for the CDC 6600 computer. (auth)

7382 (LA-4248) FLUROESCENCE EFFICIENCIES AND COLLISIONAL DEACTIVATION RATES FOR N_2 AND N_2^+ BANDS, EXCITED FROM DEPOSITION OF SOFT X RAYS. Mitchell, Kenneth B. (Los Alamos Scientific Lab., N. Mex.). Aug 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

7383 (LA-tr-69-21(Draft)) POLAROGRAPHIC ANALYSIS OF SOME EXPLOSIVES. Martel, G.; Vignaud, M. Translated for Los Alamos Scientific Lab., N. Mex., from Ind. Chim. Belge; No. T32, 626-9(1967). 14p. Dep. CFSTI.

7384 (LA-tr-69-28(Draft)) CRYSTAL STRUCTURE OF TETRACYANOTRIAMMINE COMPLEX OF MONO AND DIVALENT COPPER HAVING THE FORMULA $Cu_2(CN_2)Cu(CN)_2(NH_3)_3$. Dunaj-Jurco, M.; Poraj-Kosic, M. A. Translated by A. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Chem. Zvesti; 21: 24-9(1967). 10p. Dep. CFSTI.

7385 (NYO-910-126) BIOLOGICAL EFFECTS OF RADIATION AND RELATED BIOCHEMICAL AND PHYSICAL STUDIES. PROPOSAL NO. 6. PHYSICAL-CHEMICAL STUDIES ON NUCLEIC ACIDS AND DERIVATIVES. Progress Report, April 1, 1968-June 30, 1969. Petermann, Mary L.; Cavalieri, Liebe F. (Sloan-Kettering Inst. for Cancer Research, New York). Aug. 31, 1969. Contract AT(30-1)-910. 8p. Dep. CFSTI.

Ribosomes isolated from rat liver were dissociated and the properties of subunits and proteins were studied. Data on the molecular weight and sedimentation coefficients are presented. Isolation procedures for DNA polymerase were tested. Factors influencing the replication of DNA in Escherichia coli and phage T4 were studied. (C.H.)

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7387 (SC-R-68-1888-A) PRECISE ADMITTANCE OF A MONOPOLE. Chang, David C. (Colorado Univ., Boulder. Dept. of Electrical Engineering); Harrison, Charles W. Jr. (Sandia Labs., Albuquerque, N. Mex.). 30 Aug 1968. 45p. Dep. CFSTI.

7388 (SC-RR-69-648) ON BEEBY'S MULTIPLE-SCATTERING-THEORY APPROACH TO LEED. Madden, Hannibal H. (Sandia Labs., Albuquerque, N. Mex.). [1968]. 86p. Dep. CFSTI.

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Development and work during the year 1966 are outlined. Activities of the IAEA Laboratories at Vienna and Seibersdorf, the International Laboratory of Marine Radioactivity at Monaco, the International Center for Theoretical Physics at Trieste, and the Middle Eastern Regional Radioisotope Center for the Arab Countries at Cairo are included. Publications and preprints issued during this period are listed for each laboratory. (auth)

7390 (UCRL-19021) SOME APPLICATIONS OF TRANSMISSION ELECTRON MICROSCOPY. Thomas, G. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1969. Contract W-7405-eng-48. 40p. Dep. CFSTI.

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Abstracts are given of papers presented at the meeting. Indexing was prepared for 640 papers. (M.C.G.)

For abstracts of individual papers see: 5588-5590, 5605-5609, 5616-5642, 5662, 5663, 5687-5690, 5714-5729, 5746-5752, 5758-5764, 5767, 5770, 5775-5781, 5790-5806, 5811-5829, 5831-5846, 5852-5868, 5898-5900, 5918-5920, 5954-5956, 5970, 6031, 6037-6039, 6052, 6074, 6089, 6172-6176, 6181, 6182, 6197-6201, 6210, 6211, 6219-6247, 6249-6253, 6267-6272, 6282, 6283, 6287-6290, 6341, 6403, 6404, 6527, 6534, 6553, 6576-6609, 6783-6786, 6810-6817, 6834, 6835, 6860-6865, 6906-6920, 6963, 6964, 7010-7045, 7055-7071, 7073-7099, 7101-7113, 7117-7140, 7143-7165, 7172-7243, 7245-7260, 7262, 7265-7322, 7324-7352, and 7354-7374.

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